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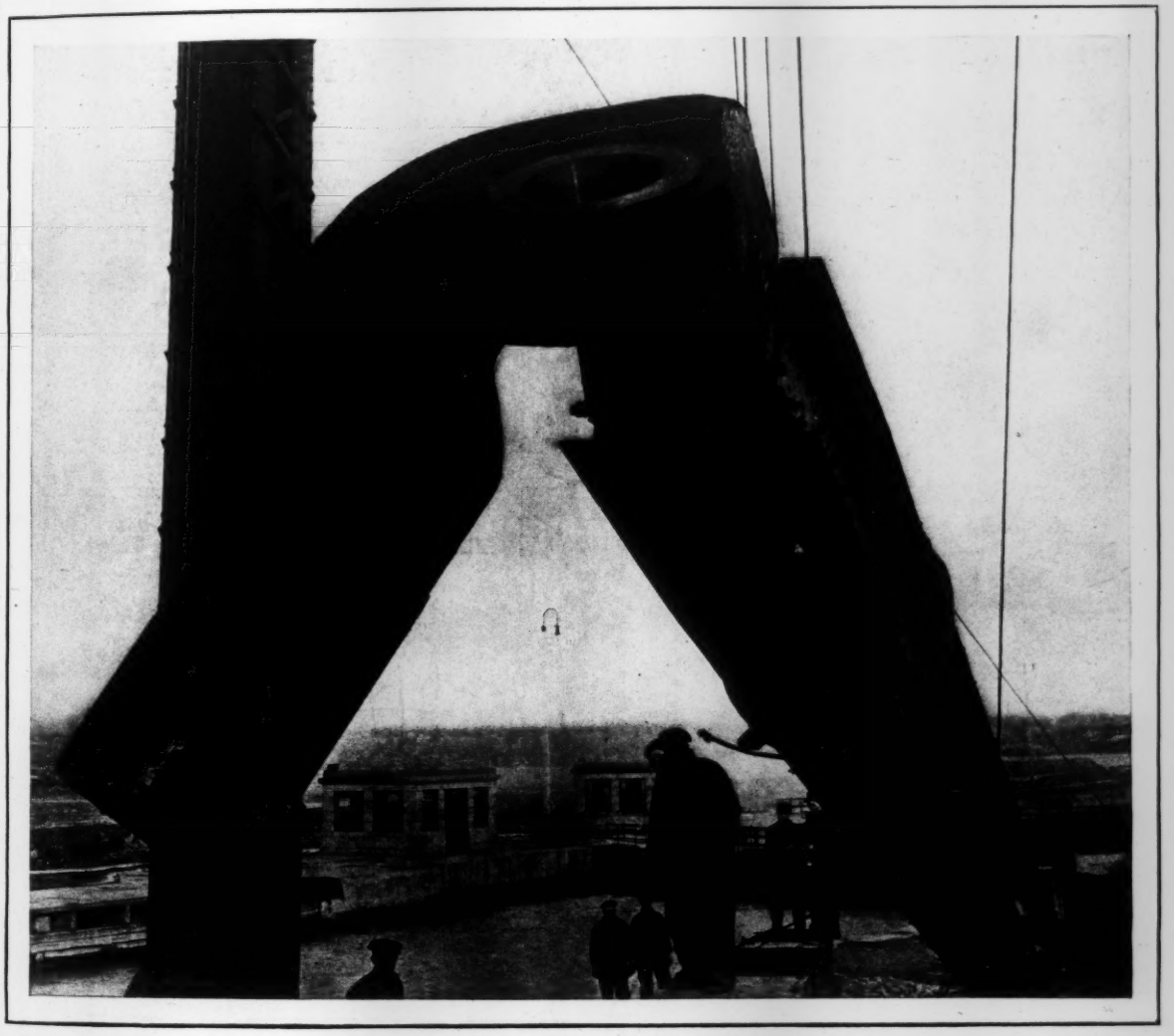

Gooseneck of Derrick for Handling Parts of Emergency Dam in Soo Canal

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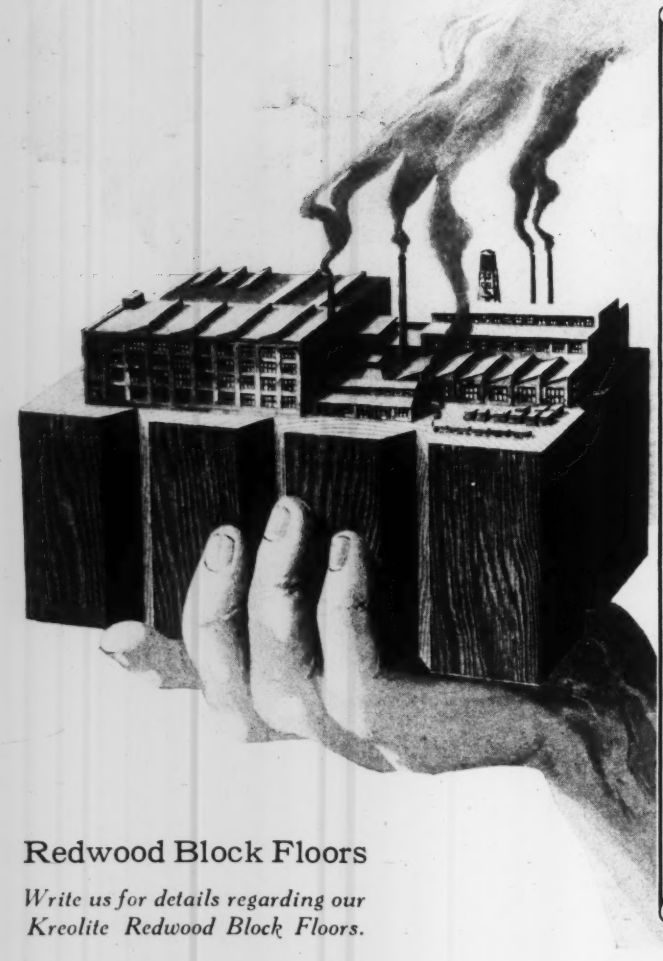

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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What Flying Needs

MANEUVERING as easily as a motor boat on a placid lake a large dirigible carrying twenty-odd men appeared to our East Coast cities on Oct. 15 less than three days out of Berlin. A week before a similar ship crossed the continent in half the time of our fastest trains. Passenger transportation by air is an assured possibility. To those to whom time is important—and in these days the number is many—air transportation offers such advantages that it is bound to prosper and develop. But in spite of these spectacular flights and the dreams they raise, the old objection to flying as a commercial proposition still remains. The ratio of dead weight to live-load carried remains so high that freight carriage is far in the future awaiting some revolutionary discovery not yet even predictable. Kipling's famous "night mail" required a ray that somehow multiplied buoyancy. Fact today must borrow from fiction before we scrap our land vehicles and water craft.

Railroad Centennials

A CLAIM that the Pennsylvania is the oldest railroad in America, both in the matter of its charter and actual construction, an honor heretofore generally conceded to the Baltimore & Ohio, has been put forward by the assistant secretary of the former company, Samuel Harden Church. Mr. Church, in a letter to the president of the Pennsylvania System, goes back through a maze of interesting but hardly conclusive data to a charter obtained by John Stevens in 1823 for a Pennsylvania Railroad Co., claiming this charter as the beginning of the present Pennsylvania Railroad, apparently disregarding the fact that this charter was repealed in 1823. In the matter of construction Mr. Church bases his argument that the Pennsylvania is older than the Baltimore & Ohio on the fact that, "In April, 1828, three months before the first ground was broken by the Baltimore & Ohio by Charles Carroll of Carrollton, Maj. John Wilson began the location of the Pennsylvania Railroad." In presenting this as evidence Mr. Church appears to overlook the fact that preliminary engineering work of a similar nature to the location work carried on by Major Wilson had preceded the breaking of ground for the Baltimore & Ohio and that breaking ground, rather than the start of surveys, is usually conceded to mark the start of construction. The date of the breaking of ground for the Columbia, Lancaster & Philadelphia Ry., which Mr. Church claims was the successor to the Pennsylvania Railroad Co. of 1823 charter, is not given but Mr. Church does state that four miles of railway were put under contract in April, 1829. Even if ground was broken immediately upon the execution of the contract, the Baltimore & Ohio still has nearly a year's start on the Pennsylvania. It would appear, therefore, that from the evidence presented the distinction of being the oldest railroad in this country still remains with the Baltimore & Ohio.

Cement Research Reviving

RESEARCH never sets out to prove anything; its aim is to find new truths. Given a sufficient collection of such truths old theories may be verified or new ones discovered, but the essence of the research is to reveal fact. The tests that Mr. Merriman is carrying out on cement in the New York Board of Water Supply are distinctly of this nature. He is not setting out to prove anything at all about cement—except possibly that the so-called standard specification does not insure a standard cement—but he is finding out some things that may prove useful in the study of cement, its manufacture and its application. Such studies as these have been long needed in cement research. It is perhaps too much to say that they have been stifled by the very successful campaign for a standard specification, but certainly that campaign tended to discourage the individual cement companies from trying to find out too much about their material or the cement user from attempting to penetrate the mystery of cement formation or behavior. If all cements were assumed to be alike what was the use of studying them further. Finally, however, this pleasant fiction of uniformity or standardization fell of its own weight and the cement maker bowed to the cement user's demand that further investigation of the obvious variations be made. The joint study of the Bureau of Standards and the Portland Cement Association is the result. Meanwhile, some few users, like Mr. Merriman, are studying the question, too. All of this is worth while, but there should be more of it and what is done should be better co-ordinated. We are approaching a new stage in the development of cement. All the facts that research can give us are needed.

Canadian Politics Interferes

SECRETARY Hughes' note to the Canadian government on the St. Lawrence inquiry brings out into the open the issue which for some months has been holding back the joint consideration of this most important international question. Once more Canadian internal politics bids fair to retard progress. Ontario, committed to a public power ownership policy, must get more water from Niagara and from the upper St. Lawrence, but taking already nearly twice as much of the flow at the Falls as the United States the province knows well enough that a fair adjudication will give her but little more there. As a matter of strategy therefore the Ontario authorities must continue to harp on the Chicago diversion, that being the one sure way to gain general Canadian approval. The Dominion government, meanwhile, cannot afford to antagonize Ontario and so must play her game and insist on an examination only of the Chicago situation and refuse to discuss Niagara at all. Our State Department, on the other hand, plays fair. Possibly Chicago is not entitled to her demanded 10,000 sec.-ft. That is a proper ques-

tion to examine, but obviously the St. Lawrence problem is one problem from the head of Superior to at least the international line and only by studying it *in toto* can it be fairly settled. We have our sectional issue in this St. Lawrence disposition, just as marked as is Canada's, but so far we have not allowed it to govern our effort to adjust matters to the best interest of both East and West in Canada and the United States.

Automobile Saturation and Road Costs

AUTOMOBILE manufacturers who for years have seen the increased production of cars confound the prophecies of saturation of the automobile market should begin to realize that a new element has entered the field and that it behooves them to prepare for it. Heretofore the prophets of production saturation have based their prophecies on the supposed inability of the public to find any more money for automobiles. But the money continues to be found, and it will continue to be found probably for a long time if the prospective owners can find any place to run their automobiles in comfort and with pleasure. No one sees the congestion in our city streets and on our county highways without realizing that the saturation point of automobile production is not going to be measured by the purchasing power of the people but by the capacity of our highways. Unless more and better highways are built and more and wider streets are opened the use of the automobile will become a diminishing utility or pleasure. The lesson to the automobile manufacturer should be plain. Hitherto he has fought every effort to make the automobile pay for any road or street construction. Maintenance he was willing to support because obviously the car wore out the road, but construction he held was the duty of the whole public and not that part of the public that operated motors. As a theory that may still be reasonable; but if the automobile manufacturer reads the signs aright he will see that practically he had better do all he can to help get new roads and streets because sooner or later—and very soon near our crowded centers—the demand for automobiles is going to be seriously diminished by the simple fact that there will be no place to run them.

Asphalt Stability Test

OUTSTANDING in the technical proceedings last week at the asphalt road conference at Louisville was the announcement by Prevost Hubbard, chemical engineer, The Asphalt Association, of the development of a simple test for stability of asphalt mixtures. In a later issue the technique and some of the results of the new test will be considered in detail. At the moment it need only be noted that the test, so far as its results have been proved, promises real constructive service. It is simple and so inexpensive in apparatus and operation that it can be set up at any field mixing plant. Its results are so prompt that they can be made a guide almost of daily plant operation. Again it is a test of sufficient precision apparently for laboratory studies of wide scope into asphalt-sand mixtures and sand mixtures without binder or cement. Naturally there remain some irregularities in procedure and results to be ironed out by practice and experience. It is yet a new test and as described in our news section this week it has its usefulness all ahead of it.

More on Engineers' Income Tax

THERE seems to be some confusion regarding the interpretation of Judge Lowell's decision on income taxes for consulting engineers in municipal practice, as noted in our issue of Oct. 9, due to the fact that while the decision was specifically rendered in the matter of excess profit taxes the comment makes it apply to income taxes. It is a fact that the case in which the decision was made was brought in the matter of excess profit taxes and the ruling of the lower court judge specifically relates to excess profit taxes. The assumption has been generally made, however, that the ruling when carried through to the upper court would also apply to straight income taxes as well, inasmuch as both income and excess profit taxes were a part of the same law. It should be noted, however, that the specific quotation from the law given in the ruling on p. 581 of the issue noted above which states that "officers and employees under the United States" are exempt applies only to the excess profit taxes. The income tax law of 1917 exempted from taxation on income the President of the United States and certain federal judges; all other federal employees paid the straight income taxes. Employees of state, county, city, etc., governments were exempt from both income and excess profit taxes. The United States employs few consulting engineers, so the question of exemption of federal employees has little bearing on the taxes which consulting engineers have to pay. It is the minor subdivisions of the government that employ consulting engineers and these engineers will be affected by the final ruling on Judge Lowell's decision.

For Continuous Service at the Soo

THE important place held by Great Lakes commerce in the industrial life of the nation is not generally appreciated, even by engineers. The volume of traffic is greater than the foreign commerce of all the sea ports on the coast of the United States, and is four times that of the Panama Canal, while the ton mileage of freight is one-sixth that of all the railroads in the United States. During last year the iron ore carried from mine to furnace amounted to 65,000,000 tons, coal to the amount of 34,000,000 tons was sent to the West and Northwest for distribution and over 11,000,000 tons of grain were floated to market on Great Lakes waterways. A necessary link in this system of transportation is the St. Marys Falls Canal on the American side of the St. Marys River and the Sault Ste. Marie Canal on the Canadian side, each provided with locks having a lift of 20 ft. to overcome the St. Marys Rapids, through which must pass all freight to and from Lake Superior. Through these canals, which for commercial purposes may be considered as one, there passed last year 75 per cent of the iron ore produced in the United States on its way from the Lake Superior mines to the furnaces. It flowed through the locks at the average rate of 10,000 tons an hour throughout the entire navigation season. No further comment is necessary to indicate the vital dependence of the steel industry upon the continuous service rendered by this waterway. The result of a prolonged interruption is comparable to the breaking of the main conveyor belt in a manufacturing plant.

To care for this immense tonnage more than four hundred freight vessels are employed throughout the

navigation season of eight or nine months. These vessels have an average capacity of 8,000 tons and many are capable of carrying a cargo of 15,000 tons. Terminal facilities are on a similar scale and nowhere is bulk freight so efficiently handled as in the principal harbors of the Great Lakes.

The works at St. Marys Falls Canal are constructed by the United States Engineer Department. Realizing, as few people in the country outside of those directly concerned do, the economic importance of this traffic, the army engineers have been wise in not only building the lock structures of rugged stability but in providing for their quick repair in case of accident.

The structures designed for such protection are built with the hope that they may never be called into use. In fact, while devices for the purpose have been in place for 45 years, the emergency that they are intended to control has not arisen on the American side and only once on the Canadian side. Nevertheless, considering the disastrous result of an indefinite delay to a commerce equal to one-sixth of the railway ton mileage of the country, the cost of insuring continuity of service spread over so many years is indeed small and entirely warranted.

Elsewhere in this issue, L. C. Sabin, identified with the works at Sault Ste. Marie for many years, describes the latest type of emergency dam built to protect the two new locks from serious interruption should an accident occur. The general form of the structure, designed to be placed in a current of 12 or 15 ft. per second, is new, and it contains several unique features of interest, including the large derricks employed in placing the dam.

Stress Measurements in Buildings

IT IS a curious fact that very little experimental work has been done in the measurement of stresses in the steel frames of buildings. The structural engineer engaged in the design of this type of framework has apparently been content to go ahead on the basis of the current assumptions as to the way in which such frames act, without verifying these assumptions by test. Similarly, he has accepted the various artificial methods of procedure for wind stress calculation, knowing that they have little contact with strictly rational theory, without seeking verification of the correctness of these methods by test. Stress measurements have been made quite extensively upon bridges and upon concrete building frames. The reasons why steel building work has been left without investigation are somewhat obscure, but it seems likely that one of the reasons is the difficulty, not to say impossibility, of securing wind-stress measurements under extreme conditions. The difficulty of providing for access to measurement points on steel framework after a building has been placed in service is no doubt also a factor.

The work that has been done in the field of steel building frames, such as the measurements made by James E. Howard on the frames of several buildings in New York City a dozen years ago, did not lead to very promising results. Facilities were lacking for conducting the work on a sufficiently extensive scale to permit of that massing of data which appears to be essential to the obtaining of reliable average results in work of this kind. The former work hardly even showed that dead-load stresses have a regular and satisfactory linear relation to the applied load; and this in other words means that they did not demonstrate conclusively that such stress measurement work was feasible.

In the Des Moines test recently reported, a valuable demonstration was given of this particular point. The measurements were sufficiently numerous and extensive to give satisfactory averages. They showed an excellent correspondence between stress and applied load, throughout a large range of load and a considerable variety of erection conditions. Thus, they have given proof that the instrumental methods available for such work are satisfactory and adequate, and that the results can readily be made sufficiently consistent to permit of a good insight into the action of the steel frame. This demonstration opens the way for further work, which should result in the accumulation of a sufficient mass of data to lead to deductions having structural value.

Among the immediate possibilities of such building frame stress measurements are a satisfactory exploration of dead-load stress distribution. In all probability the stresses from dead-load in frames of such a high degree of statical indeterminacy will be found to exhibit many peculiarities and unexpected features. In connection with dead-load stress measurements, it should be possible to investigate such typical cases of live-load stress distribution, provided means can be found to continue measurements after a building has been placed in service. Any work of the kind, however, will be of great magnitude and will require much devoted work and a large expense. This may be gathered quite fairly from the Des Moines work, in which nearly 200 gage lines were established and observed, yet only three cross-sections of four columns in a building were under study. The net results from this very extensive investigation in fact are quite modest. The data obtained throw little light on irregularities of stress distribution; from one standpoint their most useful showing may be said to be this: That at certain points of heavy columns where one might reasonably expect considerable bending to be developed by distortion or secondary effect, there is generally speaking no bending. Relatively large amount of bending was found at one or two of the points, but this did not seem to be a regular feature of the frame and its reasons still await explanation.

When study of dead-load and live-load stress distribution has been entered upon, means may perhaps be found for investigating wind stress distribution. This, however, will be a far more difficult matter to arrange for. To observe a building frame continuously at times of high wind would appear to be an inconvenient and unsatisfactory plan of experimentation. A better method may be found by applying known lateral forces to a building or one bent of a building, where a special location (possibly two buildings closely adjoining) gives opportunity for applying known horizontal forces in lieu of natural wind pressure.

It may be hoped that the subject of such stress measurements will engage the interest of structural engineers widely enough to bring about the initiation of extended experimental work. Such work is both too extensive and too widely scattered to be a proper field for investigation by one individual, or even by a committee. The applicability of an organized plan of research to the subject is by no means evident. More probably, the interest and co-operative effort of a considerable number of structural engineers, in different locations, would afford the most favorable chance for progress.

New Type Movable Dam Guards Soo Canal Locks

Quarter-Million-Dollar Emergency Structure Insures Service Continuity to Lock Gates of St. Marys Falls Canal—Bridges, Wicket Frames and Needles Handled by Huge Derricks

By L. C. Sabin
General Superintendent, St. Marys Falls Canal.
Sault Ste. Marie, Mich.

STOPPING a vessel carrying 10,000 tons of cargo, is comparable with delaying four large freight trains. The St. Marys Falls Canal has an average daily traffic equivalent to that carried by 120 trains of 50 cars each, while the ton-mileage of the vessel freight passing this waterway in the eight months season of navigation equals one-sixth of the total ton-mileage of all the railroads in the United States. The accommodation of this traffic is accordingly of the greatest importance to the business interests of the country, and any reasonable expense incurred in the improvement, maintenance and protection of this and other Great Lakes waterways gives ample returns in service. A possible cause of serious delay to shipping is the breaking of a lock gate, either by some mistake in its operation or by collision of an approaching vessel.

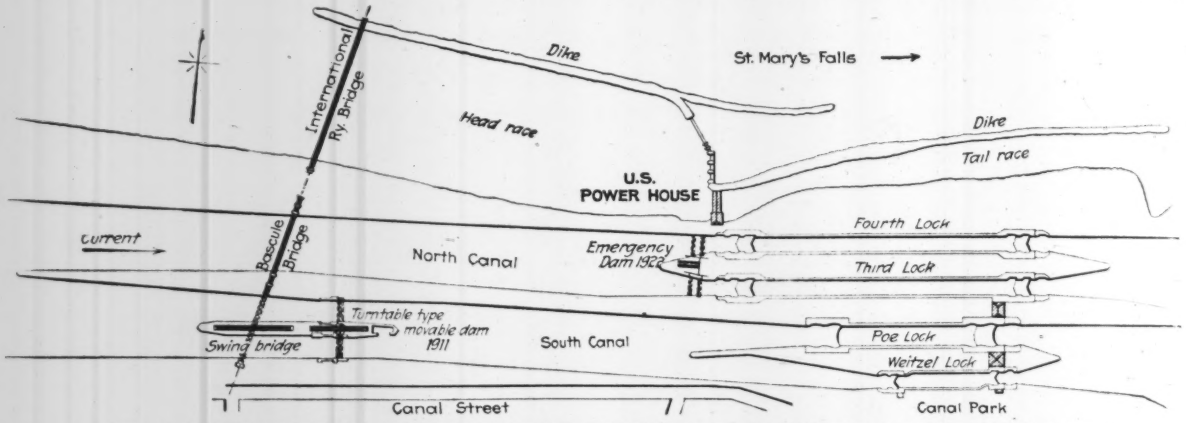


FIG. 1—UPPER APPROACH AND GROUP OF FOUR LOCKS AT ST. MARYS FALLS CANAL AT THE SOO
The new emergency dam will close the entrance to lock 3 or lock 4 should anything happen to any of the gates serving them.

It is impossible to eliminate entirely the possibility of a serious accident happening to a lock gate in use without introducing devices that complicate ordinary lock operations. Such devices may easily involve time losses that in the aggregate would exceed the delay likely to be caused once in several years by the occurrence of the accident which they are designed to prevent. On the other hand, bearing in mind the possibility of a gate being destroyed, thereby permitting the two levels to communicate, it is only reasonable to have ready for operation an emergency device which will stop the flow after the accident occurs, in order that the situation may be put under control within a reasonable time. The purpose of such a device is usually filled by some form of movable dam.

The first movable dam at St. Marys Falls was built in 1881 to protect the Weitzel lock. A swing span, supported on a center pier, carried revolving wickets attached to its downstream chord, which could be lowered in a current to rest against a sill across the bottom of the canal. The second one, built after the deepening of the canal, and still in use to protect the Weitzel and Poe locks, is similar in type, but covers two channels, is more elaborate in details and is operated electrically. During 70 years of lock operation on the American side it has never been necessary to use an emergency device, and there was but one occasion on the Canadian side when the operation of such a dam was essential to the prompt replacement in service of a damaged lock. Two vessels in the Canadian lock in 1909 were on the upper level, bound downstream, one in the lock and another just entering through the upper gate. The lower gate was restraining the entire head of 20 ft. An upbound vessel approaching the lock to await her turn for passage, got out of control through mismanagement of the machinery and, colliding with the lower gate near the mitering post, forced the leaf upstream enough to break the miter. Thereupon the pressure of water unhinged the gates, allowing the two levels to communicate. The boat in collision was whirled out of the way by the rush of water and the vessels on the upper level were carried through the lock on the crest of the wave. The current set up had a velocity of about 15 ft. per second in the lock chamber. Because a movable dam, similar in general form to the swing bridge dam above the Poe lock, had been provided in the Canadian canal for such an emergency, the lock was again in commission in 13 days after the accident occurred.

To devise an emergency dam structure which can be placed in a current of 15 ft. per second and close an opening 90 ft. wide and 24½ ft. deep and still not interfere with navigation when not in use, is the problem involved in furnishing lock gate protection to the two new locks.

Between 1907 and 1909 these new locks were built with a new canal leading to them located north of the older channel serving the Weitzel and Poe locks. The depth in this canal and the locks is 24.5 ft. The canal is 280 ft. wide at its narrowest point and the locks are each 80 ft. in width. Between the locks a pointed nose pier of concrete extends upstream some 300 ft. These locks each have two pairs of operating

gates at each end, so operated that at no time are there less than two gates separating the two levels. While it was thought that this precaution might be sufficient to guard against serious accident, further consideration of possible exigencies and the growing importance of the traffic led to the conclusion that the locks should be protected by some type of dam that could be operated under any conditions likely to arise.

As the upper canal leading to these two locks is spanned by a bascule bridge, there is no island on which to locate a center pier for a revolving structure. The choice therefore lay between a dam of the Poiree or Chanoine type to rest, when not in use, in a recess

The downstream, or wicket, bridge carries, on the face of the lower chord of its upstream truss, short hinge pins to receive the upper ends of the wicket frames or girders. The operating bridge, placed, when in use, 34 ft. upstream from the wicket bridge, carries a winch truck for handling the lower ends of the wicket frames. The clearance between the bridges when in place is sufficient to allow the passage of a wicket in horizontal position.

The wicket frames, 3 ft. wide, are two-cell steel girders, with sides of channel section and middle rib of I-beam. At the top the two sides are prolonged in lugs in which slots are cut to fit over the hinge

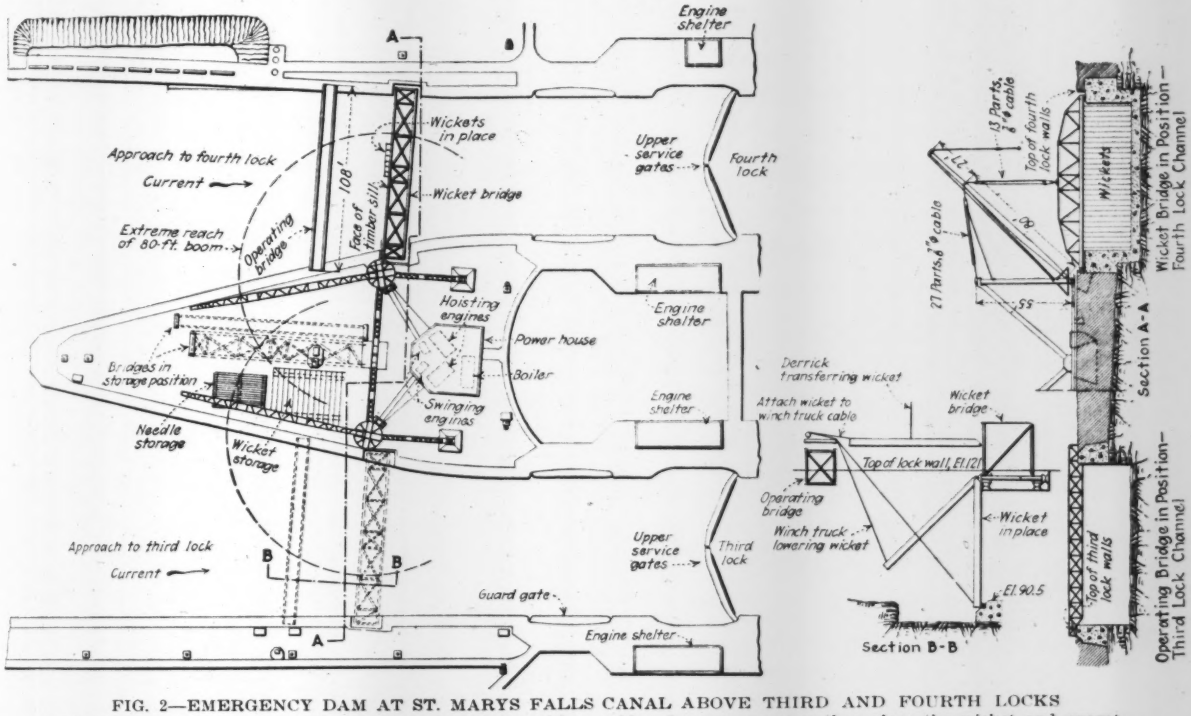


FIG. 2—EMERGENCY DAM AT ST. MARYS FALLS CANAL ABOVE THIRD AND FOURTH LOCKS

Two stiffleg derricks having a capacity of 82 tons with main booms 80 ft. long and extensions of 27 ft. have boom falls with 27 parts and load falls of 13 parts of ¾-in. special cable. In an emergency they place the wicket and operating bridges across the lock approach and then deliver the wickets which are lowered to place by the winch truck.

in the bottom of the canal, or some type that could be operated from the nose pier immediately above the two locks.

The lock axes are 220 ft. apart, so that for this location a dam of the swing bridge type in use in the other canal would require an overall length of over 300 ft., the outer 80 or 90 ft. at each end being over the canal and the central 120 or 140 ft. over the pier. That such a structure would be unwieldy was not the only objection. The operation of the dam in case of accident to one lock would put both out of commission until such time as the dam could be removed. Moreover, it would be unsightly when not in use, and would interfere with the view which lock operatives should have of approaching vessels.

New Type of Dam Selected—Consideration of the existing physical conditions and the requirements to be met resulted in the selection of a type of dam consisting of two movable bridges, with detachable wicket frames and needles, all to be stored on the canal wall and handled by means of heavy derricks, one on either side of the nose pier.

pins. When in place the bottom of the frame rests against an oak sill set in a concrete wall extending across the bottom of the canal. The two open cells of the wicket frames were designed to be filled by timber or steel needles, to be driven to place or pulled down by a cable. Wooden needles were first provided, which developed serious friction. Steel shutters, housed within, and hinged to, the wicket frame and revolving into position to close the opening when desired, were then suggested. After a study of this and other types, it was finally decided to use steel needles of channel section, to be pulled down by a cable attached to the lower end, and passing over sheaves housed in the wicket.

A heavy derrick is placed on each side of the nose pier adjacent to the two channels. Each derrick is capable of handling the bridges, and an extension on the boom, with whip line, can handle the wicket frames.

Method of Operation—To place the dam in position, the main derrick on that side of the canal to be closed lifts the heavy wicket bridge, swings it across the canal, and places it on abutments vertically above the

timber sill. The derrick then similarly places the light operating bridge about 34 ft. upstream from the wicket bridge. This operating bridge carries on its upper deck the hand-operated winch truck, running on a longitudinal track. The bridges being in place, a wicket frame is picked up by the whip line of the derrick and swung horizontally from its storage position into place between the two trusses. It is then

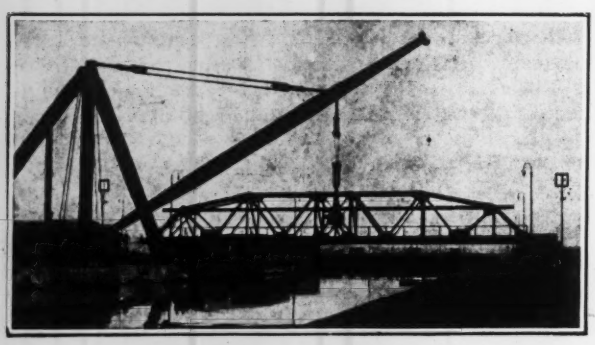


FIG. 3—SWINGING WICKET BRIDGE TO PLACE ABOVE THIRD LOCK
Another derrick can swing the same bridge to the left into place above the fourth lock.

lowered to a point where slots in the upper end of the frame can be engaged over two hinge pins of the wicket bridge and the cable from the winch truck on the operating bridge can be attached to the lower end of the wicket frame.

The whip line from the derrick is then released, leaving the wicket frame resting at the top on the two hinge pins engaging the lugs on the wicket and supported at the lower end by the line from the winch truck. The winch truck line being then allowed to pay out, the frame revolves about the hinge pins until it hangs in a vertical position with bottom resting against the timber sill. The line is then disconnected from the winch and the end so attached to the operating bridge as not to allow any slack to interfere with placing the next frame.

The thirty wicket frames may be placed in any predetermined order gradually to cover the span. When they are all in position the steel needles are inserted in any order desired and are pulled down to place by the whip line of the derrick attached to the cable that leads over sheaves to the bottom of the needle. The flow then remaining is that due to leakage between the wicket frames and around the needles. This can be stopped by the use of trash, if required, but it is expected the current resulting from such leakage will not prevent closing a lock gate, whereupon the dam can be removed and lock repairs initiated.

The Wicket Bridge—The wicket bridge, a through girder with riveted connections, has a span of 98 ft. and weighs about 82 tons. The two vertical trusses, 12 ft. high, are spaced on 12-ft. centers. Since the structure cannot be tested under full load, and because of the importance of adequate strength should the emergency arise requiring its use, maximum stress was assumed at 15,000 lb. per square inch of net section in axial tension with corresponding values for other stresses. The lower chords of the vertical trusses, connected by heavy bracing, form the rugged horizontal truss, designed to take the load due to water pressure, the function of the vertical trusses being merely to carry the dead-load and the wickets. The water pressure was assumed to be that due to a head of 28.5 ft. the proportion going to the bridge resulting in a horizontal load of 8,000 lb. per linear foot.

To form the wicket hinge, short pins, 2½ in. in diameter, are placed at intervals of 36¼ in. along the upstream side of the horizontal truss. Each pin is held by a pair of angles riveted to the upstream chord, and serves to engage the side of two adjacent wicket frames.

Recesses were cut in the canal walls to receive the bridge when in place. These recesses are 18 ft. long and 5 ft. deep, so that the bridge shall rest just clear of high water. Each end of the bridge is supported by two cast-iron pedestals, one under either chord, and the horizontal thrust is taken by a bumper casting set into the downstream face of the recess just back of the horizontal truss.

The Operating Bridge—The operating bridge is a deck girder with riveted connections, having a span of 108 ft. and weight of 20 tons. The vertical trusses are 8 ft. deep, spaced on 6-ft. centers. The live-load was assumed at 15,000 lb. vertical for the weight of the winch truck and the vertical component of the pull on the cable, and 10,000 lb. horizontal for the horizontal component of the cable stress. The top chords of the truss form the track for the winch truck, and a plank floor extends the entire length of the structure to facilitate operation of the winch truck. The latter is operated by crank through gear drive, and when in use is anchored to the upstream side of the truss.

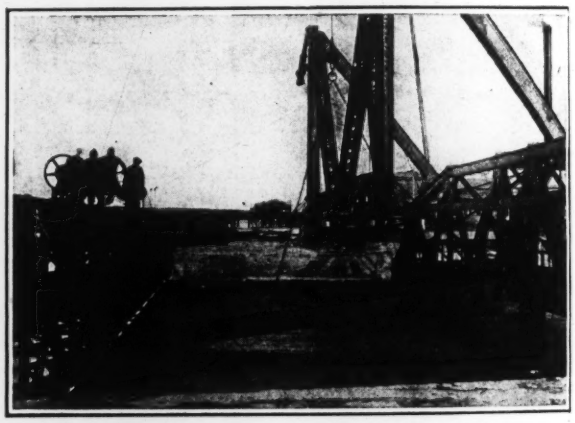


FIG. 4—WICKET ON HINGES BEING LOWERED BY WINCH LINE

The bridge rests directly on the concrete canal wall and is anchored against overturning by an eyebar attached to the upstream truss.

Stiff-Leg Derricks—The derricks are of unusual size, each being capable of lifting 82 tons at a radius of 75 ft. The mast height is 53 ft. between bearing centers, boom 80 ft. long with lighter extension of 27 ft. length for a whipline to handle extreme wickets. Sills are 46 ft. 9 in. in length, held down by eyebars set in concrete anchorages. The stiff-legs, 71½ ft. long, are connected to the top of the mast through a heavy two-arm cast-steel goose-neck and 18-in. diameter gudgeon pin. The boom falls are pin-connected to the main boom, and to a forged steel collar at the mast top, through eyebars.

The bottom mast bearing is a pivot 22 in. in diameter

and 12 in. deep, phosphor bronze bushed, working in an oil bath and resting on three flat disks, the upper and lower ones being forged steel and the middle disk of phosphor bronze. At the top the 18-in. gudgeon pin has bushed bearing in a goose-neck 14 in. in vertical height. The maximum pressures, in pounds per square inch, are for top bearing 925 horizontal and 1,850 vertical, and for mast foot 1,000 horizontal and 2,810 vertical.

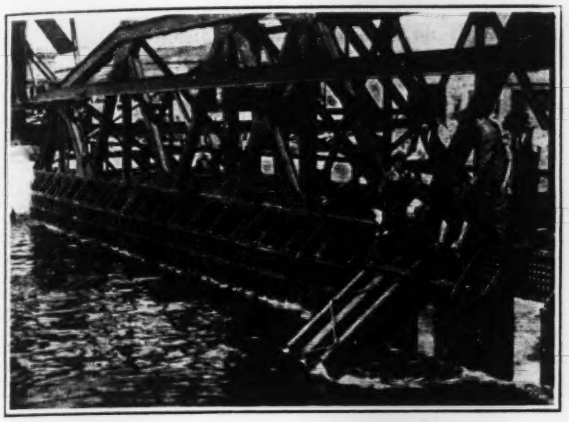


FIG. 5—WICKETS ALL IN PLACE BUT TWO
Steel needles pulled down by a cable or driven with a small pile-driver attachment close the openings in the wickets, thus making the dam fairly tight. Trash is to be used should a tighter job be required.

The boom falls are figured for a stress of 150 tons with 27 parts of cable, which gives a stress in the becket cable of 11,100 pounds, and assuming friction 56 per cent, a stress in the lead cable of 17,300 lb. The load falls are designed for a stress of 82 tons, with thirteen parts of cable, giving a stress on the becket of 13,100 lb. and on the lead line of 16,500 lb. The line is a special ⅞-in. cable, six strands of 29 wires each, with a wire rope core, having a guaranteed strength of 68,000 lb. As the critical strength was expected to be that of the cable fastening in the open sockets, three sockets were made up with 3-ft. length of cable each, and these failed at 67,000, 69,400 and 69,350 lb. respectively. The first failure, below the specified strength, was believed to be due to the slipping of one strand during the process of socketing.

Each derrick is operated by independent hoisting and slewing engines, served by a 100-hp. boiler. While the lock machinery is electrically operated, the use of a steam plant for this emergency use was dictated by the desire to be independent of electric supply in case of a serious accident. The hoisting engines are double 12x12 cylinder, 3-drum engines, with rated line pull of 16,000 lb. The slewing engines have double 6½x8 cylinders, with two outboard drums having a rated line pull of 10,000 lb. The boiler is of 100-hp. capacity, marine, internally fired, of sufficient capacity to operate readily at the same time one swinging engine and one slewing engine.

The plant is housed in a concrete and steel building, made to harmonize with the cut-stone lock structures in the immediate vicinity.

Tests and Modifications—On the completion of the structure it was tested under such conditions as it was possible to produce by opening the filling valves of one lock, thus creating a considerable current, though of course not approaching the conditions that would obtain should the lock gates be carried away. These tests were valuable in disclosing certain minor operating defects, leading to slight modifications.

One interesting development in the trial operation of the derricks illustrated the importance of lubrication in structures of the magnitude concerned. The moving parts at the base of the mast run in an oil bath, the maximum pressures on steel and phosphor bronze disks being 2,810 lb. per square inch. In the preliminary operation the oil reservoirs were filled with ordinary engine oil of good quality. In attempting to swing the derricks, the load on the swing lines was such as to crush the cast-iron drums of the slewing engines. Even with light load the friction developed was double that which had been anticipated. Repeated operation for the purpose of limbering up the moving parts did not result in material change in the indicated friction coefficient. The oil in the reservoir was then replaced by a good quality of graphite grease and the friction was immediately reduced about one-half, indicating that the oil had been too light for the pressures involved. The bearings at the top of the mast and in the sheaves were also provided with the same lubricant. To guard against further trouble, however, the slewing engines were supplied with new drums of cast steel and a sheave was inserted in the lead line to the drums, making a two-part connection, thus reducing by one-half the stress on the lead line and the speed of swinging, both of which were considered desirable.

In placing the wickets in a current it developed that after the slots at the top of the wicket were engaged on the hinge pins, and the wicket was being lowered in the current by the line to the winch truck, there was a tendency for the wicket to twist, lifting one side of the wicket off the pin. To correct this the pins were provided with hold-down links, which could be temporarily attached to the wicket during the process of lowering.

It was originally proposed to close the openings in the wicket frames by wooden needles, which should be pulled down by a cable or driven to place by small pile-driver attachment. The friction developed, however, even with the small difference in head at the time of the trial operation, was such as to raise a question whether this general method would prove practicable even if steel needles of similar form were substituted. Accordingly, plans were first prepared for steel shutters or gates to be housed in the wicket frame, which, being hinged along one side, could be released to swing into position across the current when desired. Some objections appearing to attach to this form, however, experiments were made to test the relative friction developed by sliding needles of wood and steel. These tests indicated that if steel needles were used they could be pulled down to place with cables, and they are therefore to be installed.

Cost and Advantages—The cost of the dam in place, including power plant, was about $250,000, or approximately $1,400 per linear foot of opening. The work was carried out, however, at a time when exceptionally high prices for structural material prevailed, the unit price of structural steel erected in place being 15½c. per pound.

While the requirements indicating a structure of this character do not frequently arise, the type has certain marked advantages for closing large channels under

emergency conditions. Among these may be noted:

Reasonable certainty that it can be operated and will fulfill its function when required, its location on the canal wall removing it from any probability of injury either from ordinary causes or from conditions incident to the emergency. This location above water also results in ease of repair and upkeep.

Comparative facility of operation, which can be tested as frequently as desired. It is the practice to test the machinery about once a month. The time required to place the dam is greater than in the case of the swing bridge type, but in case of accident the damage would practically all take place within a few minutes, so that no structure could be placed quickly enough to prevent it.

There is no possibility of the dam forming any obstruction to navigation when not in use. The only part remaining in the canal proper is the oak sill in a concrete wall below the bottom of the channel.

The dam may be used in either channel as required, and as soon as it is in place operations may proceed through the lock not affected by the accident.

Finally, the cost of construction is probably less than for any structure of similar rigidity and certainty of operation.

The structure was built by the War Department, responsible for the construction and maintenance of the St. Marys Falls Canal, under the direction of Col. E. M. Markham, of the Corps of Engineers, U. S. Army, in charge of the Detroit district. The general designs were prepared, and supervision of construction carried out, by the Sault Ste. Marie office, Isaac DeYoung, assistant engineer, and Owen M. Frederick, junior engineer, being especially assigned to the work and developing many ingenious features.

The contract for construction was awarded to the Independent Bridge Co. The contractor's engineers designed the derricks and made the detailed plans of the bridge.

Design of Paved Road for Dam Top Dayton Flood Works

Concrete Road With Gutter to Control Runoff Crowns Hydraulic Fill at Huffman Dam —Cured with Calcium Chloride

BY C. S. BENNETT
Engineer, Miami Conservancy District, Dayton, Ohio

A CONCRETE pavement designed for the top of an earth dam, where the handling of the water to prevent scour is an important consideration, has recently been completed at the Huffman Dam, one of the flood protection structures of the Miami Conservancy District in Ohio. While the type of pavement is not new, special treatment with regard to drainage was necessary as an unusual type of curb and gutter was used.

The top width of the Huffman Dam is 30 ft. and the surface of the original gravel roadway was level. The roadway section had a crown of about 6 in. Surface drainage was taken care of by constructing the side ditches in such a manner that inlets at intervals of about 450 ft. leading to paved gutters running down the slopes of the dam carried off water from the roadway. It was desirable to make the new pavement as wide as possible, at the same time making proper provision for the surface drainage so that the water would not flow over the slopes of the dam except at the gutters already provided. In order that the guard rail previously constructed could be cleared, a width of 27 ft. 8 in. from face to face of curb was adopted. The gutters on each side were made 3 ft. wide and the main pavement section 21 ft. 8 in. The pavement was designed for a level grade and has a crown of 2½ in.

Combined curb and gutter was used, though bids were received on both the combined and separate types. The gutter has a warped surface to take care of surface drainage from the pavement. The curbs are 6 in.

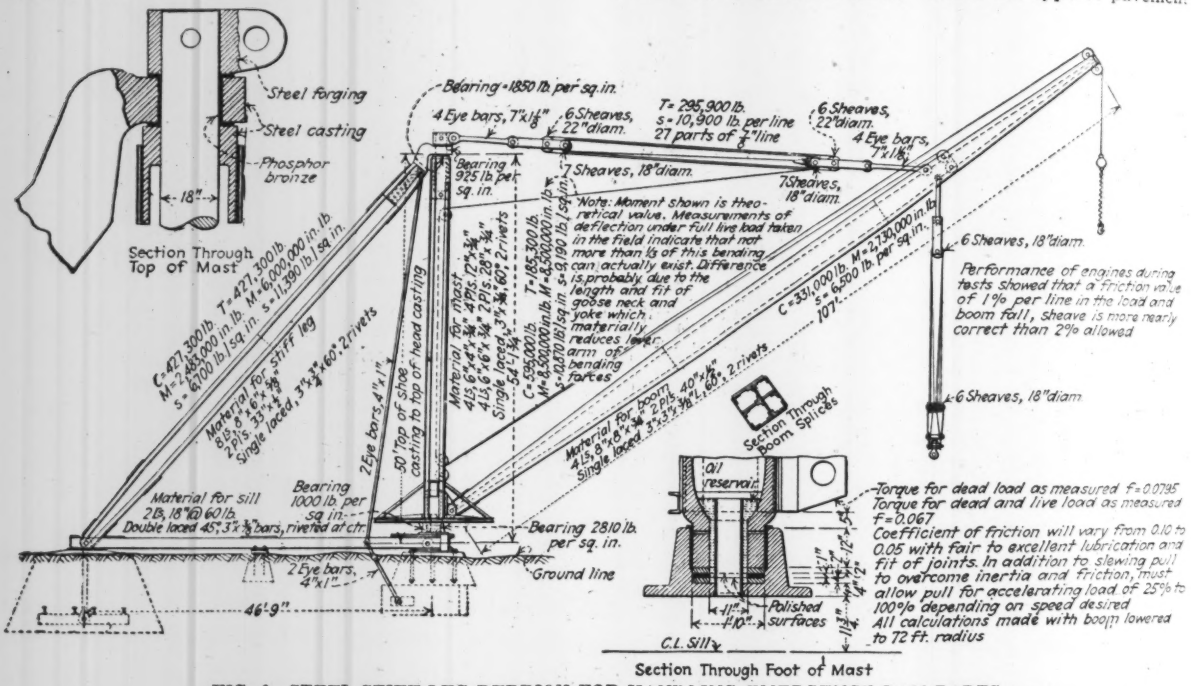

Steel forging
Steel casting
Phosphor bronze
18"
Section Through Top of Mast
Bearing = 1850 lb. per sq. in.
4 Eye bars, 7"x1⅛"
6 Sheaves, 22" diam.
T = 295,900 lb.
s = 10,900 lb. per line
27 parts of 2" line
6 Sheaves, 22" diam.
4 Eye bars, 7"x1⅛"
Bearing 925 lb. per sq. in.
7 Sheaves, 18" diam.
7 Sheaves, 18" diam.
Note: Moment shown is theoretical value. Measurements of deflection under full live load taken in the field indicate that not more than ⅓ of this bending can actually exist. Difference is probably due to the length and fit of goose neck and yoke which materially reduces lever arm of bending forces
6 Sheaves, 18" diam.
Performance of engines during tests showed that a friction value of 1% per line in the load and boom fall, sheave is more nearly correct than 2% allowed
6 Sheaves, 18" diam.
Material for stiff leg
Material for sill
Bearing 1000 lb. per sq. in.
Bearing 2810 lb. per sq. in.
Ground line
46'9"
Material for boom
Section Through Boom Splices
Oil reservoir
Polished surfaces
C.L. Sill
Section Through Foot of Mast
Torque for dead load as measured f = 0.0795
Torque for dead and live load as measured f = 0.067
Coefficient of friction will vary from 0.10 to 0.05 with fair to excellent lubrication and fit of joints. In addition to slewing pull to overcome inertia and friction, must allow pull for accelerating load of 25% to 100% depending on speed desired
All calculations made with boom lowered to 72 ft. radius

FIG. 6—STEEL STIFF-LEG DERRICK FOR HANDLING EMERGENCY DAM PARTS

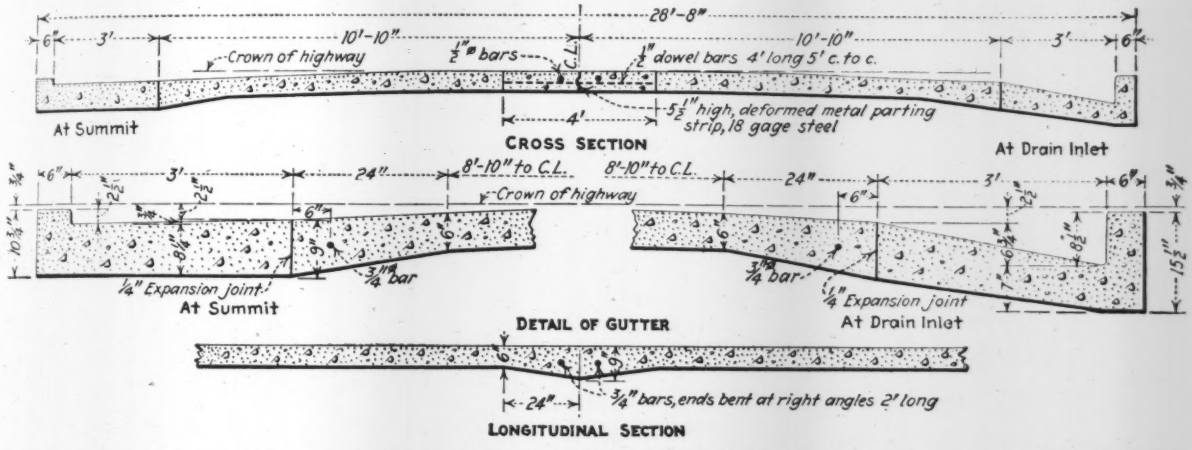
thick on top and have a depth on the inside varying from 2½ in. at the summits to 8½ in. at the troughs opposite the slope gutters already in place. The tops of the curbs are 1¾ in. higher than the edges of the pavement section. The gutter slab is 9 in. thick at the pavement edge and varies from 7 in. to 8¼ in. in thickness at the face of the curb. Expansion joints of ¼ in. bituminous material are provided between the edge of pavement and the gutter slab.

The pavement section is 9 in. thick at the sides, tapering to 6 in. two feet from the sides. A 5½-in. deformed metal parting strip runs longitudinally through the center, with ½-in. dowel bars 4 ft. in length spaced on 5 ft. centers. On each side of the metal center joint is placed a ½-in. round rod which is wired to the dowel bars. In the edges of the pavement, ¾-in. round bars are placed, spaced 6 in. from each edge. No other reinforcing is used, except at the transverse joints between the end of one day's run, and the beginning of the next run. Here the pavement section is increased to 9 in. thickness as shown on the drawing and ¾-in. rods, with the ends bent at right angles, are placed across the pavement section on each side of the joint.

Both pavement and curb and gutter sections were made of concrete of 1:1½:3 mix. Cement was furnished by the District and gravel and sand were hauled from Dayton, a distance of about 5 miles, on trucks. Special hoppers or batch boxes, each holding a batch (about one cubic yard) of sand and gravel, were used. These were loaded at the gravel plant and three hoppers were hauled on a truck. Water was pumped from the river at the south end of the dam through 2-in. pipe laid along a berm on the slope of the dam about 20 ft. below the top.

All of the curb and gutter was completed before any pavement was laid. Curb and gutter were laid in sections of 10 ft., separated by ⅛-in. steel plates on templets. These templets were shaped so that their top edges would conform to the warped surface of the gutter when set. Thus it was a simple matter to strike off the gutter surface and finish it true to slope.

No special preparation of the subgrade for the pavement section was necessary, except rolling and wetting, as the top of the dam consists of very compact gravel. The concrete was mixed and placed with a Model 21 steam-driven boom and bucket type mixer. Slump tests were made at frequent intervals, to regulate the consistency of the concrete. A maximum slump of 3 in. was allowed. However, the average slump observed throughout this job was from 1½ to 2 in. The concrete was mixed for 1½ minutes. Concreting of the pavement section was carried forward over the entire width; reinforcing and parting strips were placed about 40 ft. in advance of the concrete. A specially constructed combination tamper and strike-off templet was used to strike off the concrete immediately after it was placed and spaded. This templet spanned the entire width of pavement, the ends bearing on the gutters. It was worked forward with a sawing motion by two men at each end. High and low spots were brought to grade by workmen behind the templet and all rough spots were smoothed up with long-handled wood floats or with a hand roller. Transverse waves were practically eliminated during this process. The surface was finished with a board about ¼x10 in. which spanned the pavement section and was pulled back and forth by handles at each end. Results obtained with this "board" belting were very satisfactory. When finished the pavement was covered with burlap and kept wet until final set occurred. Curing was then completed by the application of calcium chloride at the rate of 2½ lb. per square yard of pavement.



DETAILS OF CONCRETE PAVEMENT FOR ROAD ON TOP OF HUFFMAN EARTH DAM, MIAMI CONSERVANCY DISTRICT

The job was completed in 34½ working days. The average rate of progress on curb and gutter was 270 lin.ft. per day; the best day's run was 470 ft. Pavement was laid at the average rate of 800 sq.yd. per day. The total curb and gutter amounted to 6,274 lin.ft.; total pavement 7,647 sq.yd. The cost of the job was $21,156.75 plus the cost of cement furnished by the District.

Little & Fischer, of Dayton, Ohio, were the contractors and the engineering supervision was by A. F. Griffin and C. H. Shea, representing the Miami Conservancy District.

Canal Boat Dimensions

In the description of the new type of canal boat designed to minimize wave action on the canal banks, given in our issue of Aug. 28, p. 337, the beam width was given as 70 ft.; it should have been 17 ft. 6 in.

Building a Hydro-Electric Plant on Saguenay River—II

Electrically-Driven Construction Equipment Used Entirely on Half-Million Horsepower Operation in Northern Quebec—Work Lasts Through Three Sub-Arctic Winters—30-Mile Service Railway Used

The hydro-electric power development described herein is to total 1,200,000 hp. and is being built in northern Quebec, under all of the construction difficulties that such remoteness and adverse winter temperatures imply. This is the second of three articles; the first in the issue of Oct. 16 was on "Developing Access and Habitation."

The project is being carried out by the Quebec Development Co., Ltd., with J. B. Duke, president. The late Sir William Price was vice-president and chief owner with Mr. Duke. W. S. Lee is vice-president and chief engineer; and F. H. Cothran is vice-president in charge of construction. Work is being done by force account.
—EDITOR.

II. Installing Plant and Power

VIRTUALLY the 30-mile railway system and the camp village belong to the construction plant. Here, however, plant is considered to include shops and equipment specifically performing construction operations. They alone represent over a million dollars expenditure. All are electrically operated except locomotive cranes and steam shovels, and, of course, the railway locomotives. In the aggregate the motor equipment represents 5,000 hp. These amounts indicate unusual plant magnitude which is emphasized by the statistics of main units described later. The immediate feature of interest is the plant planning, which, like the planning of railway access and of camp, was done before a hand had been turned in construction.

Conditions Influencing Plan—The outstanding conditions influencing a plan of construction are summarized in the preceding article. Two of these, isolation and lack of habitation, were met by the railway and camp construction. The far separation of the three small dams on the Little Discharge made their construction local operations with small outfits. Planning of main plant then took into consideration only the concrete structures on Isle Maligne and in a secondary way the earth dam on Alma Island. Of these structures the center of volume was within a railway haul of less than three miles—three-quarters by volume was within a mile-haul.

Chiefly the construction comprised heavy concreting, rock excavation, assembling and placing penstocks, scroll cases and other turbine emplacement steel and

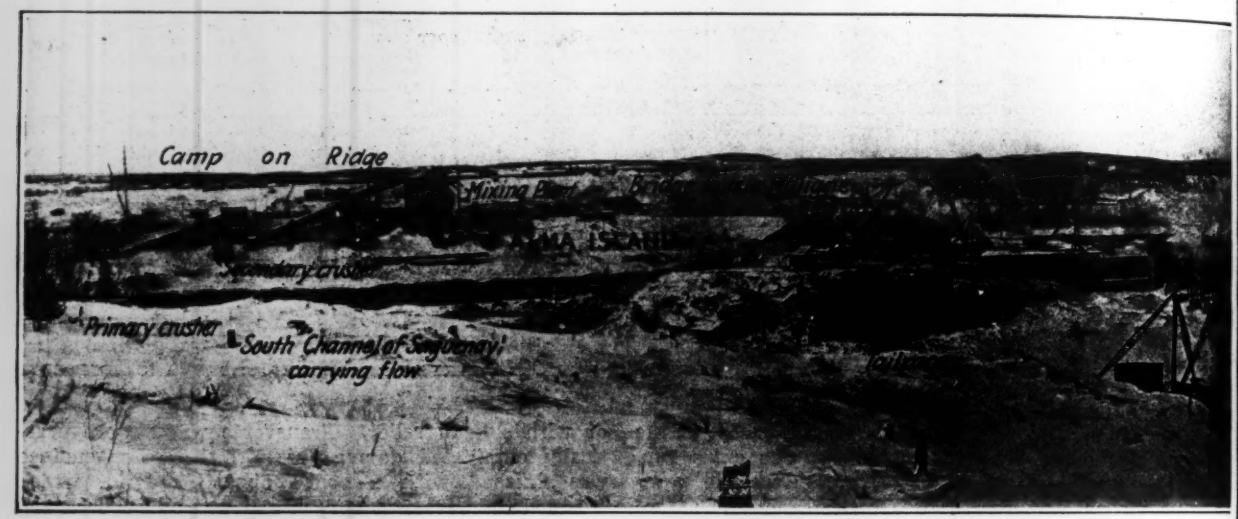


FIG. 7—LAYOUT OF PLANT AND CAMP, READY FOR CONSTRUCTION

the building of an earth dam. The earth dam being a separate structure of different nature than the others called logically for individual construction treatment independent of the main plant excepting railway service and steam shovel work. In planning the main plant, consideration was required chiefly of equipment for concrete work, rock excavation and turbine emplacement steelwork. Production and deposition of concrete were the dominant plant requirements.

Concentration of concrete volume largely in the power house and its connecting spillway has been noted. Similarly the rock excavation was concentrated in the power house emplacement and in the tailrace. As the tailrace ledge was a granitic rock, excellent for concrete, its reduction and use for aggregate was an obvious operation. A mixing plant near the power house and requiring only short hauls for crusher rock and crushed aggregate was the logical plan.

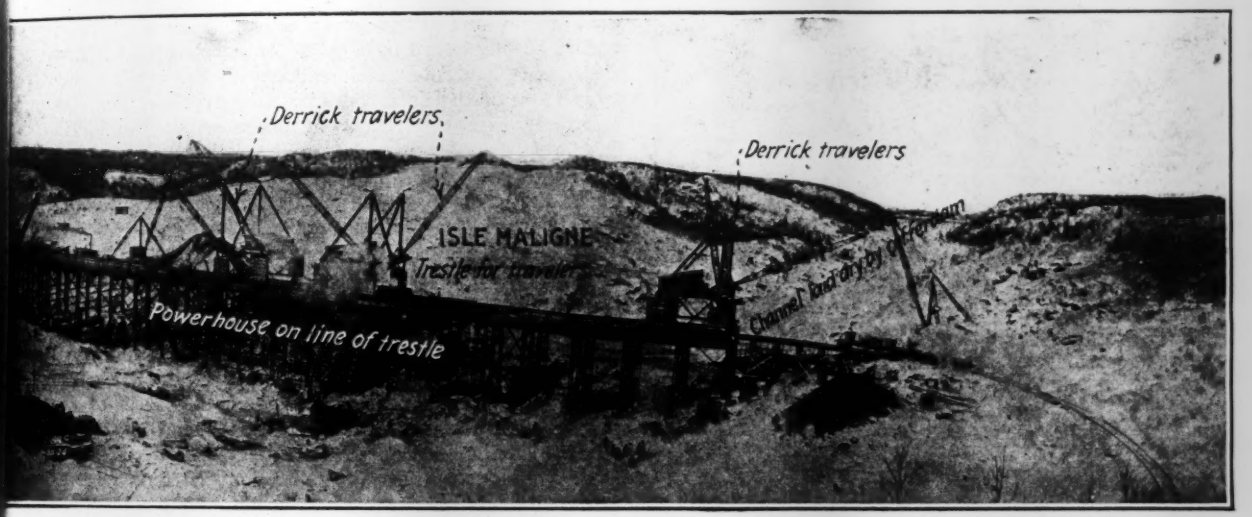
With a large crushing and mixing outfit for the power house, the extension of its services to the other concrete dam operations (spillways 2, 3, and 4) was a natural consideration. It was this idea, in fact, that

in part determined the service railway extension, as had been noted, to each spillway. With a maximum haul of 2.7 miles to the farthest end of spillway 4, a wet-batch train time of 20 min. was practicable on a well surfaced standard-gage track. Using large batch containers this time was entirely safe—indeed it gave leeway for some delay.

Following the adoption of a single central plant for producing concrete, the conditions called for large plant units. A fast schedule had been set for the development work. The volumes were large and added to this was the fact that certain critical operations, like putting in, as will be described later, the first lift of power house head wall during the short winter period of low water, demanded great spurts in output. Only by large units could the extra volume-speed be ensured. Again, large units for depositing concrete fulfilled the further purpose of handling large, assembled units of steelwork for turbine emplacements. Large container units, finally, gave greater economy of load for standard-gage railway haulage to the spillways.

a midwinter fire was only by desperate battle kept from destroying both units and did stop concreting for upward of a fortnight during the critical operation of putting in the first lift of the power house head wall. The buildings at the secondary crusher plant and mixers were almost completely destroyed and the conveyors were completely destroyed. The primary crusher was saved by dynamiting the conveyor between it and the secondary conveyor unit.

Plant for Concrete—Large capacity was the first requirement laid down for the crushing and mixing plants and as stated large capacity was sought by large equipment units. The primary unit is a 66x84-in. jaw crusher which delivers to a grizzly the rejects from which then go to a No. 15 gyratory crusher. The No. 15 crusher and the grizzly discharge into a 42-in. belt conveyor 150 ft. long which goes to a scalping screen which passes all material under 2 in. The rejects from the scalping screen go to four No. 6 gyratory crushers. Material passed by the No. 6 crushers and the scalping screen go onto a second 42-in. belt con-



WORK, SHORTLY AFTER THE INSTALLATION WAS COMPLETED

So two 4-cu.yd. mixer units were chosen and all serving equipment was planned on a corresponding output scale.

There was finally the lay of the ground favoring the central crusher-mixer plant plan. An excellent location for a gravity crushing plant was offered by the river face of the ridge on the Alma shore. On this side, too, were the quarry supplementing the stone supply from the tailrace excavation, the sand and gravel pit, and the branch railway bringing in cement and other materials. The river side of the ridge, on the crest of which was the camp, was therefore made the site of the stationary plant units. Their location is indicated by the map, Fig. 8, while Fig. 7 is a panoramic view which was taken early in the second winter of construction.

Description of Plant—The fixed plant units comprise chiefly the crushing plant, the mixing plant and the various shops and service buildings. In the crushing and mixing plants were the vitals of the half-million-cubic-yard concrete placing operation and they were designed with attention. Incidentally it may be noted here that, as will be explained later more particularly,

veyor some 200 ft. long reaching to finishing screens at the top of the mixer building. Here the screens discharge into the two end bins of a row of three, the middle bin of which is for sand and is kept full by derrick and clamshell from a dump from trestle by trains from the sand pit which was something over a mile away.

A 70,000-bag cement house stocks and handles the cement supply. Most of the cement is brought in and handled in bulk, but for emergency purposes a small quantity is shipped and stored in bags. The bulk cement cars come in at a track level with the top of the building and their cargo goes into second-story bins, but the bag cement comes in at ground level and is stored in the first story. Bulk cement is unloaded by hand but afterward all movement is mechanical. Mechanical unloaders of several sorts were tried out but under the conditions hand unloading proved less expensive. A 30-in. belt conveyor passes under the bins, from thence dips under the railway tracks and then climbs to the cement bin above the charging floor in the mixing plant. A screw conveyor placed longi-

tudinally in each bin feeds the belt conveyor. A notable fact is that the belt conveyor up to the mixer bin has a 29-deg. rise and is carrying cement to the mixers successfully.

Below the mixer house bins is the mixer charging floor, and below this are the two 4-cu.yd. tilting mixers

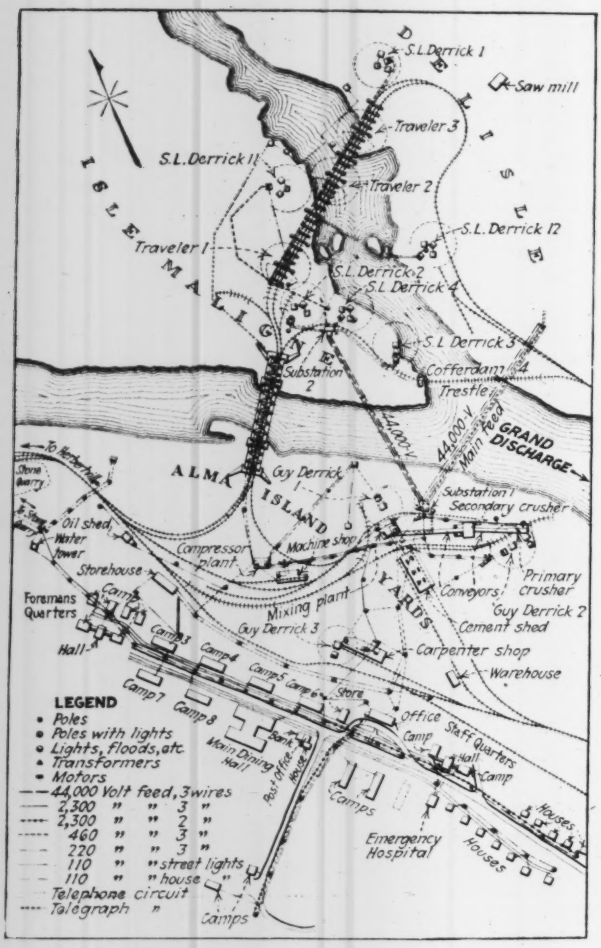


FIG. 8—LAYOUT OF ELECTRICAL EQUIPMENT FOR CONSTRUCTION PLANT AND CAMP

which discharge out-board of the building into full-batch or half-batch buckets on standard-gage flat cars which go by the service railways to any of the dam structures.

Regarded as a unit for producing concrete the plant described is notable primarily for its elimination of manual labor except machine attendance. Were it not that the bulk cement is unloaded by hand there would be only machine operations from the receipt of materials to the delivery of concrete. Second to be noted are the large size equipment units—crushers, conveyors, mixers and buckets. An unusual feature is the steam heating of the mixer house so that cold-weather hindrances to inside operations are insignificant. The same plant of two 100-hp. boilers heats the mixing water and there is a 90-hp. boiler for heating sand.

With 4-cu.yd. mixers and batch buckets the outfit for carrying and pouring batches had to be commensurate. These were standard-gage flat cars—four buckets per car, derricks at the minor operations, and a

TABLE I—DETAILS OF MOTORS FOR EQUIPMENT OPERATION

No.	Application	Type	Hp.	Volts	Amps	R.P.M.
1	Jaw crusher	Ind.	400	2,200	65	360
2	No. 15 crusher	Ind.	200	2,200	48	900
3	Conveyor, pri. to sec.	Ind.	75	2,200	14	900
4, 5	No. 6 crushers	Ind.	150	2,200	36	900
6	Conveyor, sec. to mix	Ind.	100	2,200	24	900
7	Screens, at sec.	Ind.	50	2,200	12.5	900
8, 9	Mixers	Ind				
10	Cement elevator	Ind.	10	220	29	900
11, 12	Cement spiral, mix.	Ind.	7.5	220	20.5	900
13	Screens at mix	Ind.	7.5	2,200	19	900
14, 15	Compressors	Syn.	350	2,200	75 Ph.	200
	Compressors exciter gen.	D.C.		125	80	900
16	Pump, aqueduct	Ind.	25	440	36.5	1,745
17, 18, 19	Cement shed spirals	Ind.	7.5	220	20.5	900
20	Carpenter shop	Ind	5	220	18	1,800
21	Carpenter shop	Ind	50	2,200	12.5	900
22	Machine shop	Ind.	15	200	50	1,150
23	Sand derrick	Ind.	100	440	125	900
24	Stone derrick	Ind.	100	440	125	900
25	Carpenter derrick	Ind.	100	440	125	900
26	No. 4 crusher	Ind.	75	2,200	19	900
27, 28, 29	Cement unloader	Ind.	5	440	7.5	720
30	Pump, sand tres	Ind.	30	440	32	1,720
31, 32	Cement screw	Ind.	15	440	19	900
33, 34	S. L. Derricks, Nos. 2, 3	Ind.	100	440	125	900
35, 36	Traveler 1	Ind.	100	440	125	900
37, 38	Traveler 2	Ind.	100	440	125	900
39, 40	Traveler 3	Ind.	100	440	125	900
41, 42	S. L. Derricks 4, 1	Ind.	100	440	125	900
43, 44	S. L. derricks 12, 13	Ind.	100	440	125	900
45, 46	Well machines	Ind.	10	440	125	1,720
	Log hauling hoist	Ind.	100	440	125	900

fleet of travelers at the power house as shown by Fig. 7 and in clearer detail by Fig. 9. Integral with the travelers as a concrete placing outfit is the steel trestle lengthwise of the dam and within its cross-section. Its steelwork except the floor members will be buried in the finished dam. Travelers and trestle provide a placing outfit which reaches all the power house and is above the greater volume of the construction including the steelwork for turbine emplacement.

As the major equipment for placing concrete, the travelers deserve some notice. Each consists of a frame of 43½-ft. span and 36 ft. long, with a portal clearance of 16 ft., riding on double flange wheels. Three railway tracks come within the traveler span and a locomotive crane can pass under. Fig. 9 indicates the counterweight and derrick arrangement. Each of the two derricks handles 10 tons at 80 ft. and 20 tons at 40 ft. Four travelers are operated. The derricks for other concreting operations and for different services are steel stiff-legs with 85-ft. booms and guy derricks with 100-ft. booms, and handling 15 tons and 20 tons respectively. Some 15 big derricks besides the eight on the travelers are employed.

The power of the derricks is to be noted—they are unusual machines to be used in such numbers. Any of them can handle the 4-cu.yd. bottom-dump concrete buckets. Altogether the unusual plant element is the steel trestle and traveler unit. Taking materials from

TABLE II—NUMBER AND LOCATION OF CURRENT TRANSFORMERS

No.	Location	Kva.	Pri. Voltage	Sec. Voltage
1, 2, 3	Substation 1	500	44,000	2,300/460
4, 5	Substation 1	75	2,200	220/440
5, 7, 8	Cement shed, N.E.	10	1,100–2,200	110/220
9, 10	Derrick 2 S. W.	75	2,200	220/440
11	Jaw crusher motor house	7.5	2,200	110/220
12, 13, 14	Machine shop, N.	37.5	2,200	110/220
15	Substation 1	5	2,200	110/220
16, 17	Carpenter shop, N.	5	2,200	110/220
18, 19, 20	Water tank, N.	10	2,200	220/440
21	Foremen's camp	10	2,200	110/220
22	Camp 4, S. W.	5	2,200	110/220
23	Camp 6, S. W.	7.5	2,200	110/220
24	Camp 6, N. E.	5	2,200	110/220
25	Camp staff	10	2,200	110/220
26	Rumfeldt's house, S. W.	5	2,200	110/220
27	Drill sharpening shop, S.	5	440	110/220
28				
29	Extra reserve	500	44,000	2,300/460
30, 31, 32	Substation 2	500	44,000	2,300/460
33, 34, 35	Lights, Isle Maligne	10	460	110/220
36, 37, 38	Substation 3	200	2,300	460/230

three standard-gage tracks; reaching any part with 10-ton loads and most parts with 20-ton loads; working from above down on three-quarters of the volume of work; operating eight derrick units at once either bunched or scattered, having a salvage of eight general

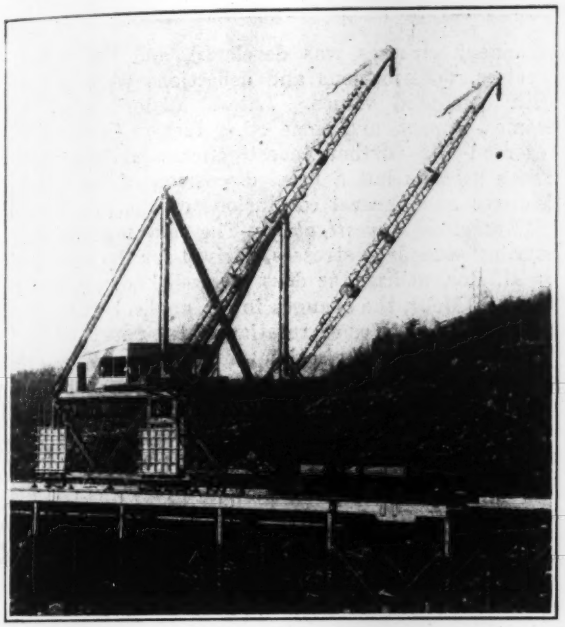


FIG. 9—DERRICK TRAVELER FOR CONCRETING POWER HOUSE

service derricks besides the carriage, these travelers constitute a unique plant unit without which perhaps the first lift of head wall could not have been gotten across the river during the low-water period of last winter.

Excavating Plant—All excavating equipment is of well-known types. There are five steam shovels, one on crawler traction and the others standard railway shovels. All drilling is done with high-speed tools of the independent rotation type and with jackhamers. Air for drilling is furnished by two 1,750-cu.ft. compressors. A separate compressor plant is provided for riveting. There are many thousands of rivets to be driven in the plate work of scroll cases, etc. This requires pressures of upward of 100 lb. which can seldom be had continuously in a general service plant. The riveting compressor is 350 cu.ft. capacity.

Shops and Sawmill—A machine shop, carpenter shop and sawmill handle repairs to plant and do considerable manufacturing. With an outfit of planers, lathe, drills, shears, bolt and pipe machines and forges the machine shop has built several flat cars, frogs and switches and made many small articles. It has been found a very useful adjunct in keeping down prices by stepping in and making parts when dealers showed a disposition to crowd up prices or got careless in service. The chief task of the carpenter shop has been form making but it has done general woodworking of various kinds. It has band, swing and rip saws, a jointer and a planer, besides all small tools. To July 1, in the neighborhood of 7,000,000 ft. b.m. of lumber had been used. Of this approximately 500,000 ft. b.m. were produced by a job sawmill. All structural timber is British Columbia fir. The sawmill produces only boards and only from such logs as may be hauled in on the snow in winter.

Electric Power Supply—Except steam shovels, locomotive cranes and railway locomotives, all construction and shop equipment is motor operated. The aggregate motor equipment is 5,000 hp. This is the largest installation, except that for the flood protection works of the Miami Conservancy District (*Engineering News-Record*, Aug. 28, 1919, p. 417), ever made for one construction operation. Many of the same reasons for selection prevailed at the two operations and the advantages gained were much the same at both.

The Price interests, also connected with the Saguenay power development, have a hydro-electric plant at Chicoutimi from which they were in position to furnish very low-priced current. On the contrary, with respect to coal, Isle Maligne is far away from the markets for year-around service. A 40-mile 44,000-volt transmission line was built from the Chicoutimi plant to Isle Maligne. At the work the current was stepped down to 2,300 volts for major motors and to 440 volts for the minor motors and was distributed about the camp and work as shown by Fig. 8. A study of this map and Tables I and II will furnish about every essential detail of power distribution and equipment.

Altogether about 50 motors, Table I, were required and all but two or three are alternating current induction machines. The larger are 400 hp. for the main crusher and the hydraulicking plant, 350 hp. for the air compressor and 200 hp. for the secondary crusher. The derrick motors were all 100 hp., and then the sizes run down to as small as 7½ hp.

Outstanding as advantages of electric power for the Isle Maligne plant are: availability, ease of distribution and reduction of attendance on machines. There are no specific figures but in going over the work notice is taken almost at once of the absence of fuel haulage, of

FIG. 10—IN THE DAM FOUNDATION AT THE BASE OF THE CONSTRUCTION TRESTLE

many scattered stores of coal, and of men serving the machine bunkers from these stores.

[*Construction methods and progress with especial notice of cofferdam building and concrete placing in winter will be considered in the closing article in our issue of next week.*—EDITOR.]

Secondary Stresses in Steel Riveted Bridges

Notes on a Comprehensive Series of Tests and Analytical Studies Carried Out by an Association of Swiss Steel Fabricators

By O. H. Ammann
Civil Engineer, New York

IN VIEW of the increasing importance attached to secondary stresses in bridge design, as evidenced by the inclusion in recent specifications of provisions making allowance for such stresses, it appears timely to call attention to one of the most comprehensive and thorough recent investigations of secondary stresses, and to consider whether, in the light of its results, the new practice accomplishes what can be its sole aim, namely, more consistent proportioning of different members of the same structure or of different structures.

The term "secondary stresses" is an extremely vague one and, unless clearly defined, is apt to find widely divergent interpretation in different minds. Ordinarily the term denotes the difference between the axial stresses in the members of a riveted truss, as calculated on the assumption of centric and frictionless hinged connections, and the extreme-fiber stresses in the members, as calculated on the assumption of perfectly rigid connections. Neither of these assumptions conforms to actual conditions. The Swiss tests show conclusively that the actual stresses depend largely upon the relative elasticity of the gusset plates, upon the ratio of the free length to the theoretical length of the members and upon other influences not ordinarily considered. The method of erection may also affect them. In view of these facts it is to be feared that the inclusion of secondary stresses in common specifications, unless they are clearly and elaborately defined, may lead to confusion and diversity in the practice of designing steel bridges rather than to safer and more accurate procedure.

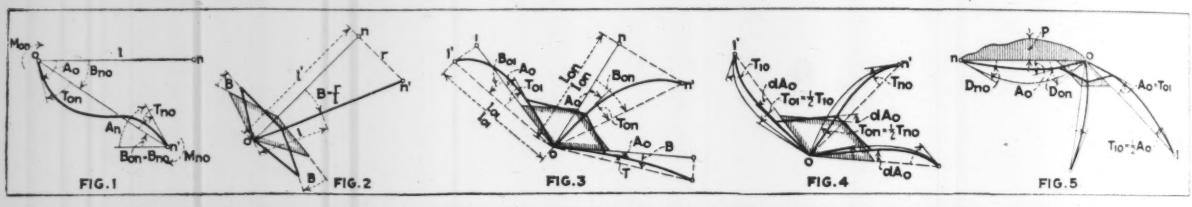
Careful theoretical and experimental investigations into the nature of secondary stresses, however, are only of the greater value because of this fact; only through such investigations can the engineer acquire a full appreciation of the nature of such stresses. But he will need to interpret the findings and apply them judiciously in order to suit them to varied conditions of practice.

The Swiss studies, extending from 1916 to 1922, were carried out by the Technical Commission of the Association of Swiss Bridge and Structural Steel Manufacturers. The report, written by M. Ros, secretary of the commission, is accompanied by a large number of illustrations and tables, and forms a most valuable contribution to the literature of secondary stresses.

A great variety of structures is covered by the investigation; plate girders, single and multiple-intersection trusses, continuous trusses, arches, and a chain suspension bridge. A new method of calculation of secondary stresses was developed, and the measured stresses, deformations and deflections were compared with computed values. Lateral distortion of cross frames, impact, and some other factors in design, are reserved for further investigation and later report. Space permits but a brief discussion of the essential features and general conclusions of the investigation.

Theoretical Investigation—The new method of calculating secondary stresses, derived for the commission by M. Ros, utilizes, as does the well known method of Prof. O. Mohr, the changes in the angles between members and the angles of rotation of the panel points due to the elastic deformation of a truss. From these angular changes the secondary stresses are readily determined.

The method is simple of application, both for a fixed series of load concentrations and for a moving load as used in the construction of influence lines. The many



DEFORMATION OF JOINT OF A TRUSS AND EFFECT OF GUSSET PLATE ON BENDING OF MEMBERS

observations having disclosed fair agreement of the calculated and the measured angular changes (measurements were made with clinometers and deflectometers), this method of calculation is convenient for use in any secondary-stress investigation.

The tests also showed, however, that it is not correct to compute the secondary stresses from the measured angles without making due allowance for the elasticity of the gusset plates. Since that allowance is difficult, or impracticable, the only reliable way to determine actual secondary stresses is by direct measurement by extensometer.

The aforementioned method of calculation was applied to the theoretical determination of the secondary stresses and their effects upon primary stresses from the following sources: (1) Riveted but centric connections; (2) eccentricity of the axis of members; (3) loading between panel points; (4) variation of the moment of inertia of a member; (5) variation in the position of the axis of a member due to changes in cross-section, or splices and other details; (6) curvature of the member caused by the secondary bending moments; (7) shortening of the member by the gusset plates; (8) elastic deformation of the gusset plates; and (9) influence of the secondary stresses upon the primary stresses and upon the deflections of the truss.

The influence of the bending of the members by the secondary stresses, (6), is appreciable only in very slender compression members, in which it may increase the secondary stresses considerably.

The determination of the stresses under (1) to (6) offers no difficulties. The effects under (7) and (8),

however, depend upon the size and elasticity of the gusset plates, and in view of the extremely complicated stress action in these plates numerous measurements are required to determine these effects with a fair degree of approximation. The experiments in that respect appear to justify the assumption that the effect of the gusset plates can be provided for by multiplying the secondary bending moments M, as calculated for the theoretical ends of a member, by the ratio of theoretical length l to actual or free length l_1 (between gusset plates) of the member, and by assuming the moments $M\frac{l}{l_1}$ to act at the ends of that free length (at edge of gusset plates). This effect of the gusset plates may be very considerable.

The influence of the secondary stresses upon the primary stresses and deflections of a truss (9) has in most cases been found to be negligible.

New Method of Calculation—Measurements made by the commission on a railroad bridge in 1917 revealed the fact that the measured angle of rotation of any panel point is always the mean value of the angles of rotation of all those members which meet at that point. It appears logical to utilize this fact for the derivation of a simple and lucid method of calculation of the angles A which, according to Prof. Mohr's method of calculation, constitute the unknown values.

For a truss with k panel points there are k unknown angles A which, when determined, permit the calculation of the bending moment in any member o-n at panel point o by the formula (refer to Fig. 1),

$$M_{on} = \frac{2EI}{l}(2T_{on} + T_{no}) \qquad (1)$$

in which I is moment of inertia, l is length, and T_{on} and T_{no} are the angular deflections of member o-n at its ends o and n respectively. Substituting for T_{on} and T_{no} their equivalent values $A_o - B_{on}$ and $A_n - B_{no}$ we have for the bending moment, since $B_{no} = B_{on}$,

$$M_{on} = \frac{2EI}{l}(2A_o + A_n - 3B_{on}) \qquad (2)$$

from which the secondary stress may be readily determined by the formula $s = \frac{M}{S}$, in which S is the section modulus of the member.

The new method for the determination of the angles of rotation A is one of successive approximation. Its application to a truss with perfectly rigid and centric connections and uniform moment of inertia of the individual members is as follows:

If a member o-n (Fig. 2) performs a rotation B about one of its ends o, as a result of a certain loading, it will cause an equal rotation B of the gusset which is rigidly connected with it. This angle B can, most conveniently, be determined by direct measurement from a Williot diagram $\left(B = \frac{r}{l}\right)$. If several members are connected to the same gusset o and assumed to turn freely about their other ends (Fig. 3) the gusset o will rotate by an amount A_o which depends upon the rotations B of the various members and their respective degrees of rigidity $\frac{I}{l}$,

$$A_o = \frac{\Sigma B\frac{I}{l}}{\Sigma\frac{I}{l}} \qquad (3)$$

the summation being extended to all members connecting at o. This rotation is accompanied by bending of each member with an angular deflection at o of:

$$T_{on} = A_o - B_{on} \qquad (4)$$

Correspondingly, owing to its actually rigid connection, the opposite end of the same member is subjected to an angular deformation (Fig. 4) of

$$T_{no} = A_n - B_{no} \qquad (5)$$

and this, in turn, effects a secondary rotation of panel point o by an amount $\frac{1}{2}T_{no}$. The primary rotation A_o as found by formula (3) has therefore to be corrected by an amount

$$dA_o = \frac{\Sigma\frac{1}{2}T_{no}\frac{I}{l}}{\Sigma\frac{I}{l}} \qquad (6)$$

the summation being extended to all members connecting at o, and the corrected rotation of the gusset becomes:

$$A'_o = A_o + dA_o$$

From these new values of A_o, corrected angular deflections T are found by again applying formula (4),

$$T'_{on} = A'_o - B_{on}$$

and by inserting these new values of T in formula (6) a further correction of A'_o can be effected. Depending upon the rigidity of the members, these corrections become rapidly smaller and finally negligible.

The final or correct value A_o for any point o will fulfill the condition $\Sigma M = o$, the summation of the moments M, as obtained by formula (2), being extended to all members meeting at that point.

The application of the method may further be shown for the case of a member loaded between panel points, as by its own weight.

If member o-n (Fig. 5) had hinged ends it would, under the transverse load p, deflect by angles D_{on} and D_{no} at o and n respectively. The gussets will partially resist this effort and their respective rotation will, analogous to equation (3), amount to

$$A_o = \frac{D_{on}\frac{I_{on}}{l_{on}}}{\Sigma\frac{I}{l}} \text{ and } A_n = \frac{D_{no}\frac{I_{on}}{l_{on}}}{\Sigma\frac{I}{l}} \qquad (7)$$

the summation being, in each case, extended to all members connecting at the respective panel point.

This value of A_o must be corrected by an amount dA_o which represents the influence of the angular deflection T_{no} of the opposite end and which is found by applying formula (6). The values T_{no} in this case are alike for all members meeting at point n and equal to $T_{no} = A_n$. The value A_n is to be similarly corrected. The process of correction is to be continued until dA becomes negligible. The final values A introduced in the following formula give the bending moment at o

$$M_{on} = \frac{2EI}{l}(2A_o + A_n) \qquad (8)$$

For the loaded member the moments corresponding to the angular deflections D-A at the ends are to be properly combined with the moments found for the member considered as a simple beam.

Test Work—Observations and measurements were made on 13 different bridges and on a specially built test truss of the Warren type with four panels. Besides numerous measurements of primary and secondary stresses, they embraced measurements of elastic deformations of the trusses and floor, vertical and horizontal deflections, angular deformations of truss members and deformations of gusset plates. In making the measurements instruments were often applied simultaneously on all sides of a section of a member,

at the ends as well as at intermediate sections. Some of the measurements were repeated at intervals of several years to observe changes under continued traffic.

Conclusions—Comparison of calculated and test results led to the following principal conclusions:

1. Only direct measurements by extensometer at the points of connection of the members to the gussets give reliable information as to amount and sense of the secondary stresses in the members.

2. The measured values of the secondary stresses agree satisfactorily, and often remarkably well, with the correctly calculated values in all trusses which are properly designed and free of ambiguity.

3. In all cases the measurements disclosed secondary stresses in the direction of both axes of a member, in conformity with the fact that the members form parts not only of the main trusses, but also of the lateral trusses or cross frames. The secondary stresses at right angles to the plane of the main trusses are usually small, but may be as high as or exceed the secondary stresses in the plane of the truss, especially in the case of top chords of pony trusses.

4. The agreement between measured and calculated secondary stresses is the closer the less ambiguous the truss system, the smoother the elastic line and the more slender the members.

5. The influence of the gusset plates upon the secondary stresses in the truss members may be taken into account approximately as already mentioned.

6. Eccentric connections increase the secondary stresses almost invariably and should therefore be avoided. Rigid riveted connections, on the other hand, always act favorably, distributing the moments and reducing the stresses from eccentric connections.

7. When the extreme-fiber stresses exceed the elastic limit the secondary stresses decrease rapidly, i.e., they cease to increase proportionately to the axial stresses. This points to the conclusion that for compression members with rigid connections the theoretical length should be regarded as the free buckling length, a reduction of that length being justified only where the member is forced to deform by contraflexure.

8. The arrangement of a rigid, continuous floor system has decidedly beneficial effect, not only in softening impact, but decreasing deflections and secondary stresses.

9. Where the truss system is clear and simple, the connections centric, the slenderness ratio of the members in the plane of the truss from 40 to 60, the members fairly rigid at right angles to the truss, and the riveted connections properly designed, secondary stresses will remain within acceptable limits, the more important ones generally not exceeding 15 to 20 per cent of the axial stresses.

Trusses which conform to the above conditions combine maximum rigidity with minimum secondary stresses. In such trusses the effect of the rigid connections on the axial stresses and deflections, as calculated for the ideal truss, may be neglected.

These conclusions in general confirm and reinforce conclusions already more or less well established by previous investigations. The engineer charged with the design, construction or maintenance of bridges will want to go a step further in his deductions with a view to determine whether the results of the investigation warrant modification of current practice as regards permissible unit stresses either to effect economies or with a view to greater safety.

The aim to disclose possible economies and thus put steel on a fairer competitive basis with other materials, notably reinforced concrete, was in fact, the main motive underlying this investigation. It is to be assumed that the commission conducting this investigation has reserved such deductions pending completion of its entire test program, but it is nevertheless possible to point out certain broad facts which impress themselves clearly upon the inquiring mind. These facts may be summarized as follows:

1. Both the methods of calculation and the available means of measurement of the actual stresses have been perfected to such an extent as to permit the expert engineer to establish, with fair reliability, the stress and strain condition in any modern truss under any condition of load.

2. A general application of either the calculation of secondary stresses or their measurement in the field, involving considerable labor, to all bridges is not warranted, but bridges of unusual design should be carefully scrutinized since they may be subjected to excessive localized secondary stresses.

3. While it is to be assumed that excessive secondary stresses, especially when localized due to improper design, form a source of weakness, the investigations so far made do not justify the conclusion that generally high secondary stresses caused by the rigidity of the members and connections are an evidence of weakness. On the contrary the results of the investigation indicate that rigidity of members and connections tends to prevent localization of high secondary stresses and may therefore constitute an element of safety rather than of weakness. Full information on this question could only be obtained by systematic testing to the point of destruction, or permanent deformation, of complete trusses representing various degrees of rigidity of the members and connections. In the absence of such tests we are justified in assuming that in simple riveted trusses of modern type, designed according to recent specifications, secondary stresses are fully taken care of. In fact the prevailing low axial unit stresses and the improved types of trusses and details insure a much larger margin of safety than existed in most earlier bridges. On the other hand it does not appear advisable to aim at pusillanimous economy by a general increase in unit stresses. Structures are built today for greater permanence than might have been justified in the days of rapid evolution.

4. In large bridges, which are mostly of unusual design and form exceptional cases, a full and thorough investigation of secondary stresses is warranted, and it is quite possible that such investigation will permit considerable economies both through the application of expedients to reduce secondary stresses, where otherwise they would be large, and the adoption of higher permissible unit stresses in members which are free of secondary stresses.

Winter Construction—A Correction

In the first of the series of articles on "Winter Construction" published in *Engineering News-Record*, Oct. 2, a typographical error at the top of the first column on p. 534 credited certain comment on time lost on account of cold weather to J. Reid Fitzpatrick. The name should have been J. Reed Kilpatrick, vice-president of the George A. Fuller Co., New York City.

New Studies in the Properties of Portland Cement

Solubility of Cement in Sugar Solutions—Relation Between Solubility and Tensile Strength Shown to Be Marked and Useful—Effect of Carbon Dioxide on Cement

By Thaddeus Merriman
Chief Engineer, Board of Water Supply, City of New York

IN A PREVIOUS article under the heading "Some Requirements in the Study of Portland Cement" (*Engineering News-Record*, July 17, 1924) the need of more detailed and extended study of the characteristics of portland cement was emphasized.

The standard specification of the American Society for Testing Materials insures to the consumer a cement which, within the limits of the prescribed tests, is a reasonably uniform product. That is to say, a cement which complies with the specification requirements will, when used in situations where the conditions of exposure approximate those under which the tests were made, produce satisfactory results. When, however, the conditions of exposure, both during the making and after the placing, differ from those which obtain during the test period, it is not always possible to predict the behavior of concrete made from cement which has satisfied the requirements.

Nearly all cement offered for test passes the specification requirements but the constructing engineer knows that substantial differences often develop in the completed concrete on different parts of the same job. These differences, as they become manifest with the passage of time, are often of such nature as to warrant the premise that they are the result of variations in the constitution of the cement which are not disclosed by the tests to which it has been subjected. In other words, the tests are not sufficiently comprehensive to make known all of the characteristics of the material. This premise may, of course, fall far short of being correct and may even not be broad enough to constitute a satisfactory expression of the problem which presses for solution. In all work of investigation it is necessary to begin with an assumption, even if it be for the sole purpose of proving that the assumption is erroneous.

Variations in Constitution—The variations or differences in the constitution of portland cement, which serves as the binder in the concrete of the period, naturally group themselves into five general classes:

(a) Those which are inherent in the cement itself and which are existent before it has been tempered with water.
(b) Those which result during the process of mixing and placing.
(c) Those which develop during the period of hydration and hardening.
(d) Those which are caused by the action of foreign substances introduced during the process of concrete making.
(e) Those which result from the action of the external agencies to which the concrete is exposed after placing.

Those variations which are inherent in the cement itself are not, in general, susceptible of direct determination. Those which become evident upon the addition of water and during the subsequent period of setting offer a broad field for study and experimentation, while the variations which are caused by foreign substances and by external agencies may be employed as an index looking toward a determination of the nature and the probable character of the variations in the constitution of the cement itself.

The investigations which have been made in the laboratory of the Board of Water Supply have been predicated on the preceding outline. The underlying purpose has been to develop and disclose as many variations or differences as possible, to contrast these variations with each other, and finally to compare the results so obtained with the results of more orthodox tests.

Solubility in Sugar Solutions—This article will deal with certain variations in the composition of portland cements which are disclosed by their differing degrees of solubility in water solutions of cane sugar. This line of approach was suggested by the well-known fact that solutions of cane sugar dissolve comparatively large amounts of the oxides and hydroxides of the alkaline earths and by certain tensile tests on mortar specimens made in this laboratory four years ago. In these tests various proportions of cane sugar were dissolved in the mixing water and it appeared, in the presence of constant quantities of sugar, that different cements displayed different characteristics both as to time of set and as to resulting tensile strength.

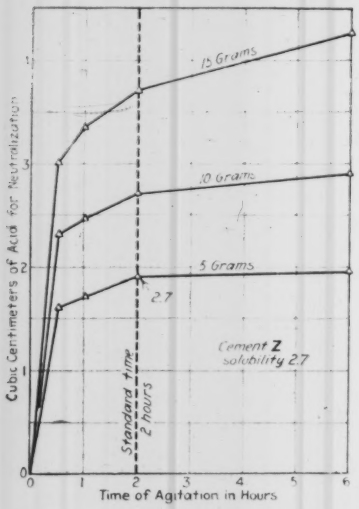
For the purpose of this investigation, a solution consisting of 15 grams commercial granulated cane sugar per 100 c.c. of water was adopted as standard. Ten grams of the cement to be examined were then agitated in a Nessler tube with 100 c.c. of the sugar solution for a period of two hours, when the resulting solution was filtered. Twenty-five c.c. of this filtrate were then titrated with half normal hydrochloric acid, using phenolpthalein as the indicator. The number of cubic centimeters of the half normal acid required to neutralize the 25 c.c. of the alkaline sugar solution could then be considered as a measure of the solubility of the cement under the conditions of the test. For convenience the quantity of acid required for neutralization has been termed the "solubility." Thus, if 3½ c.c. of the half normal acid are required to neutralize the alkaline sugar solution of a particular cement, it may be said, "The solubility of that cement is 3.5." Another cement may, in like manner, show a "solubility" of 28.3.

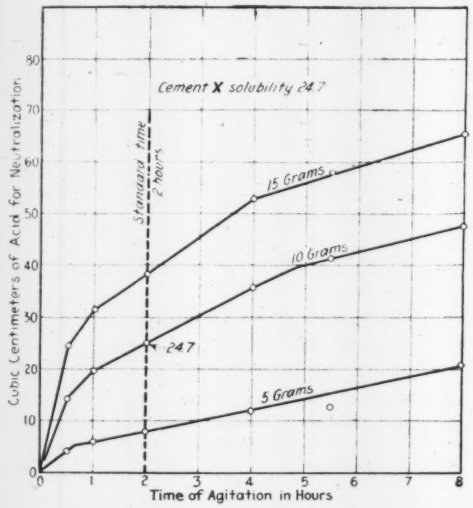
This investigation included the determination of the solubility on more than 500 different samples of cement, including a number of different brands and samples of various ages. The collateral studies as to the effect of varying the quantity of cement and the period of agitation also served to bring out a number of indications which are of great interest and probable value.

In Fig. 1 is shown the relation between the quantity of acid necessary for neutralization and the time of agitation in standard sugar solution with varying quantities of cement. The solubility of the cement used in this test was 2.7 and it has been designated as "Cement *Z*." These curves are typical of most aged cements and indicate that the degree of solution is not a direct function of either or both time of agitation and quantity of cement present.

In Fig. 2 similar curves are shown for varying quantities of a sample of "Cement *X*" the solubility of which was 24.7. The indications here are that the quantity of acid necessary for neutralization is even less a direct function of either or both the time of agitation and the quantity of cement present, than was the case under the conditions of Fig. 1.

In Fig. 3 is shown the relation between the quantity of acid required to neutralize the sugar solutions of different quantities of three different cements, *X*, *Y* and *Z*. It will be observed in this figure that the characteristics of these three cements are markedly different. The conditions under which the tests were made were identical and the differences which have become evident can be accounted for only by either or





FIGS. 1 AND 2—RELATIONS BETWEEN NEUTRALIZATION AMOUNTS AND TIME OF AGITATION, FOR CEMENT IN SUGAR SOLUTION
Fig. 1—For a low solubility cement. Fig. 2—For a high solubility cement.

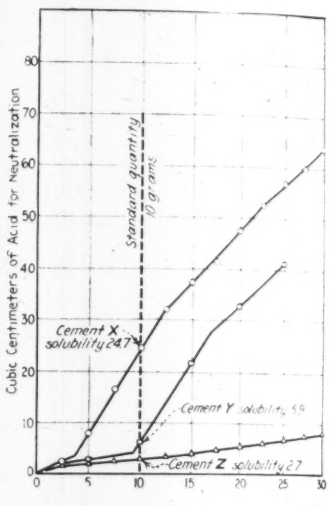

Standard quantity 10 grams
Cement X solubility 24.7
Cement Y solubility 5.9
Cement Z solubility 2.7
Cubic Centimeters of Acid for Neutralization

FIG. 3—RELATION BETWEEN NEUTRALIZATION AMOUNTS OF ACID AND DIFFERENT QUANTITIES OF CEMENT AFTER 2 HR. AGITATION IN SUGAR SOLUTION

both of two assumptions; first, that they are the evidence of actual differences in constitution or, second, that they are the result of the action of substances which are accidentally present within the cement. Under either of these assumptions the net result is the same. The causes which result in these differences must be looked for within the cement itself.

The quantity of acid required to neutralize the alkaline sugar solutions has been determined, by a number of chemical analyses, to be in direct proportion to the quantity of lime in solution. It appears, therefore, in Fig. 3, that the rate at which a cement is broken down under the conditions of the sugar test *is a function of the quantity of lime present* in the solution. It also appears that all cements are not equally resistant in the presence of equal quantities of lime in solution. The newer the cement the greater is its solubility and this may be assumed to be due to the presence of either or both free lime or lime in partial combination. Given time for the carbon dioxide of the atmosphere to reduce the free and the loosely combined lime, the cement becomes more stable and more resistant to solution.

The field of study which these observations have disclosed is of great extent. So far it has only been partially explored but the results which have been obtained indicate the possibility that a test for determining the degree to which a cement has been calcined may be developed. It also seems likely that a means for determining some of the fundamental distinguishing characteristics as between different cements may be perfected. For instance, it has been observed that 20 grams of an unsound cement will, in the sugar solution, break down almost completely within two hours, while, on the other hand, this condition has never been observed in the case of a sound cement. The usual physical test for soundness merely indicates soundness or unsoundness. It tells nothing as to whether a cement is entirely sound or whether it is nearly unsound. Were it possible to distinguish degrees of soundness our knowledge of cement would be far advanced.

The results so far with the sugar test indicate:

(1) That most portland cements, when new, show a solubility of from 20 to 30; values of 10 and 15 are not infrequent and an occasional sample will show as low as 5.

(2) That the older the cement the smaller the solubility. The minimum solubility in the oldest cements is 1.5.

(3) That the solubility of a new cement may be rapidly reduced by exposing it either with or without small quantities of moisture to an atmosphere containing more carbon dioxide than is generally present in the air.

Neat Tensile Tests—The former test for the tensile strength of neat briquets required the cement to be mixed with such quantity of water as would produce the so-called "normal consistency." This procedure was based on the thought that a fair comparison as between two cements could be secured only if the *apparent physical conditions* at the moment of molding were the same. This conception on the one hand took no account of the different solution concentrations which would result within the mass of the cement and, on the other, failed to recognize, first, that in practice no cement is ever used in the presence of so small a quantity of water, and second, that differences as between cements cannot

be distinguished if the quantities of water with which they are mixed are themselves different.

It has been shown by many investigators that the quantity of mixing water is one of the most important of the factors which go to influence the strength of concrete, but no test looking toward a disclosure of the individual peculiarities of cements in the presence of a constant quantity of water has been seriously advanced. With this thought in view a program was developed for a series of tests in which the neat cement would be mixed with 43 per cent by weight of water, since this is the smallest quantity which, as a practical proposition, can be used in the mixing of concrete. This quantity corresponds to a cement-water ratio of 0.43 and is the substantial equivalent of the water actually used in an average concrete which shows a slump of about one inch.

A mixture of cement with 43 per cent of water is essentially a grout which can readily be poured and it was soon found that the personal equation which is so

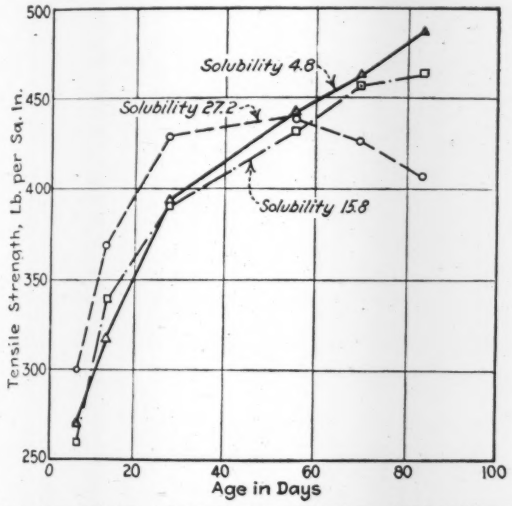


FIG. 4—STRENGTH CURVES FOR CEMENTS OF DIFFERENT SUGAR SOLUTION

large a factor in the molding of the drier mixes almost completely disappeared. The procedure followed was to fill the molds full to overflowing in the morning, and then in the afternoon to scrape off the surplus material with a wide bladed putty knife.

Perfectly uniform briquets both as to weight and texture were thus obtained. On the following morning the molds were removed and the briquets placed in water storage, where they remained until the breaking time. In this respect the usual practice as for mortar briquets was followed. All briquets were broken wet in a Fairbanks testing machine which was carefully rated both as to load and its rate of application.

In the accompanying tabulation are presented some of the results of this series, which includes altogether twenty different samples of twelve different cements. In this tabulation there is also shown the solubility for each of the cements, this value having been determined just prior to the molding of each series. Each figure for tensile strength is the average of three separate breaks. Each of the cements here reported met all of the requirements of the standard specification.

These results are grouped in the order of their solubilities and it is significant, while the strengths at

TABLE SHOWING NEAT TENSILE STRENGTH WITH 43 PER CENT WATER

Cement	Solubility	7 da.	14 da.	28 da.	56 da.	70 da.	84 da.
A*	28	255	337	386	410	469	357
B*	25	317	356	414	429	391	441
C*	27	301	394	498	460	458	516
D	28	333	406	460	444	501	363
E*	28	295	349	384	445	310	360
Group average	27.2	300	368	428	438	426	407
C*	18	268	334	414	424	523	517
F	17	273	344	377	452	488	496
E	12	213	297	387	480	442	465
G*	16	304	406	464	449	454	458
F*	16	234	314	320	356	376	384
Group average	15.8	258	339	392	432	457	464
F	3	307	307	403	420	440	433
C	6	283	333	461	472	523	567
A	5	211	270	332	435	413	455
H*	6	248	301	339	375	421	428
I	4	297	374	433	505	511	548
Group average	4.8	269	317	394	441	462	486

*Tests using 25 per cent water showed retrogression from 7 to 28 days.

28 days are greatest for those cements which show the highest solubility, that the reverse is true at and beyond 70 days. It also appears that the lower solubilities show no retrogression in strength and that the greatest ultimate strengths are developed by those cements which show the lowest solubility. All of these features are shown graphically in Fig. 4.

A parallel series of tests using 25 per cent of water was run on all of the samples reported in the preceding tabulation. Of these 15 samples, representing 9 different brands of cement, 8 showed retrogression of strength from 7 to 28 days. Those which showed retrogression during this period are indicated by an asterisk in the tabulation and it is of interest to note that seven of the eight occurred in the higher solubility groups.

From the foregoing it may be inferred that the high early strengths attained by certain types of cement are not necessarily indicative of either permanence or durability. In other words, it seems as though the internal changes which occur in cements of this type tend to cause stresses or changes of interior equilibrium which result in comparatively early loss of strength and so in possible ultimate disintegration under exposed conditions. It must not be assumed, however, in every case where failure of concrete occurs that the fault lies with the cement. So broad and sweeping a conclusion, in the present state of our knowledge, would be unwarranted.

Carbonation of Cement—It has already been noted, if a portland cement is exposed to an atmosphere containing more carbon dioxide than is usually found in normal air that its solubility will be rapidly reduced. The probable consequence of this procedure is a carbonation of the several constituents of the cement including a breaking down of the loosely bound aluminates and silicates. In effect, it is a process of artificial aging. One of the immediate effects of this treatment, in the presence of an optimum of moisture, is to convert the free lime, as well as the partially combined lime, to the stable carbonate, and so the action is to render the cement itself not only more stable but more uniform, while at the same time imparting to it qualities of permanence and durability after it has been tempered with water. A further benefit which may be predicted is that of rendering possible a reduction in the quantity of the soluble calcium sulphate which, under present methods, is added to all portland cements for the purpose of controlling the setting time. From the point of view of the manufacturer such a treatment would

also be advantageous since it would obviate the necessity of storing the clinker and so permit it to pass directly to the grinders. The exposure of the product to the action of carbon dioxide can, as a practical matter, be accomplished during any one or all of the several stages of grinding and pulverizing by feeding carbon dioxide with or without moisture into suitably arranged pulverizing machinery. The same object may also be attained by delivering the ground cement into storage bins filled with an atmosphere containing carbon dioxide, by causing the cement on its way from the pulverizing mills to pass through such an atmosphere or by separately aerating it with moist carbon dioxide at any stage after grinding and before use. Temperature at the time of exposure is an important factor. The best results are probably to be obtained at and above 180 deg. Fahrenheit.

From the standpoint of the manufacturer it is also to be noted that the process suggested would involve no appreciable increase in cost, since the carbon dioxide necessary can probably be readily obtained from the waste kiln gases after they have been sufficiently cooled and conditioned. It may also be concluded that a cement so treated will be less liable to deterioration during storage.

This suggested process and the inferences on which it is based are the direct result of the investigations which had for their purpose the study of the solubility of cements in general. It is presented as a definite and practical suggestion looking toward the attainment of a more uniform and a more stable cement which, when used in concrete, will result in a product possessed of both greater permanence and lesser solubility. Any process or procedure which will render possible a reduction in the quantity of the easily soluble calcium sulphate which is at present added to portland cements after calcination will be most desirable.

It is not possible within the compass of this article to present the more detailed results which have been obtained, not only with sugar solutions but also with solutions of glycerine and of sodium carbonate. The indications of these researches in connection with those on the tensile strengths of portland cements, when mixed with quantities of water which approximate those used in actual work, all agree with observations which have been made on the rise of temperature during the setting period and tend to confirm the substantial correctness of the suggestions presented.

Further data in regard to all of these investigations will be forthcoming in future articles of this series and, in concluding the present writing, acknowledgment is made of the invaluable help and assistance rendered by L. B. Stebbins, assistant engineer in charge of the laboratory of the Board of Water Supply.

Subway Surveys Being Made at Brussels

Surveys have been started in Brussels, Belgium, toward the construction of a subway. According to an announcement by M. Max, bourgemaster, it is planned to run the subway from the Gare du Midi to the Putterie quarter, where the central station will occupy a site originally intended for a union railway station, thus making use of some work already completed. From this central point lines will radiate to the other two principal railway stations of the city, the Gare du Nord and the Gare du Luxembourg.

Construction Progress on Bear Mountain Bridge

Bottom Chords of Stiffening Trusses Were Joined on October 6—Physical Features Described

PROGRESS on the suspension bridge now in course of construction across the Hudson River at Anthony's Nose, about 40 miles above New York City, and known as the Bear Mountain bridge, has so far advanced that the bottom chords of the stiffening trusses met on Oct. 6. This bridge has the longest suspension span in existence, and will be exceeded only by the Philadelphia bridge, the main span being 1,632 ft. c. to c. of towers, exceeding by a few feet the Williamsburg bridge, which is the longest of the East River bridges of this type. Its location is peculiarly adapted to a suspension structure as the river narrows at this point and the rock formation furnishes a natural foundation for the piers and also furnishes the necessary anchorage for the cables. On the west bank and close to the bridge approach is historic Fort Clinton, and it was at this narrow point in the river that the celebrated chain was placed to prevent passage of the British vessels in the Revolutionary War.

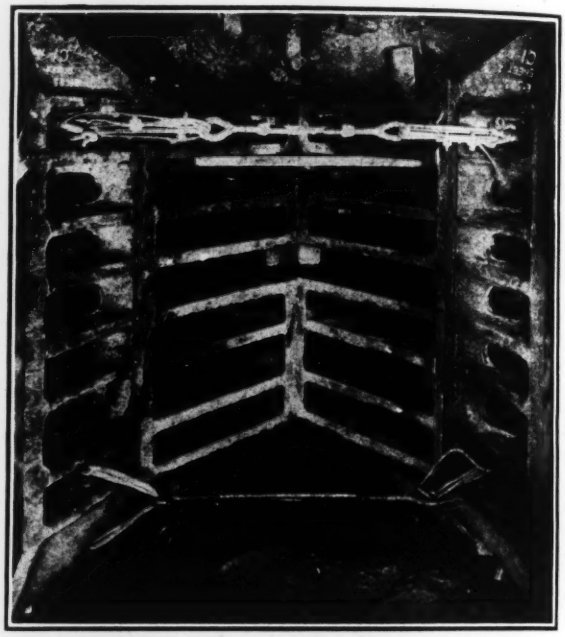


FIG. 1—ANCHORAGE CASTINGS IN PLACE IN PIT
Looking into inclined rock tunnel of north anchor chain on the west bank.

The structure is intended to provide for the traffic of the existing state road on the west side of the river and traffic which will be developed by a possible future road in addition to the road now nearing completion which forms the east approach to the bridge. A roadway of 38 ft. in width, providing for four lines of vehicles, together with two 5-ft. sidewalks, occupies almost the entire space between the stiffening trusses, which are required to be 55 ft. apart for lateral stability.

Several unusual features are embodied in the design, particularly in the anchorages and the main span trusses. The landward portion of the main cables form straight backstays, as the shore spans are so short that

they are better carried on their own piers than suspended from the cables. These backstays are carried into rock tunnels at an angle of 26 deg. with the horizontal, the ends of the cable strands being anchored in the usual way to a group of eyebars. These bars are anchored to castings, which take a bearing on the rock face of the chambers provided at the lower ends of the pits. The eyebars are laid flat and are in line with the backstays and the bearing faces of the castings make an angle of 45 deg. transversely with this line, so that a wide distribution of reaction on the rock is obtained.

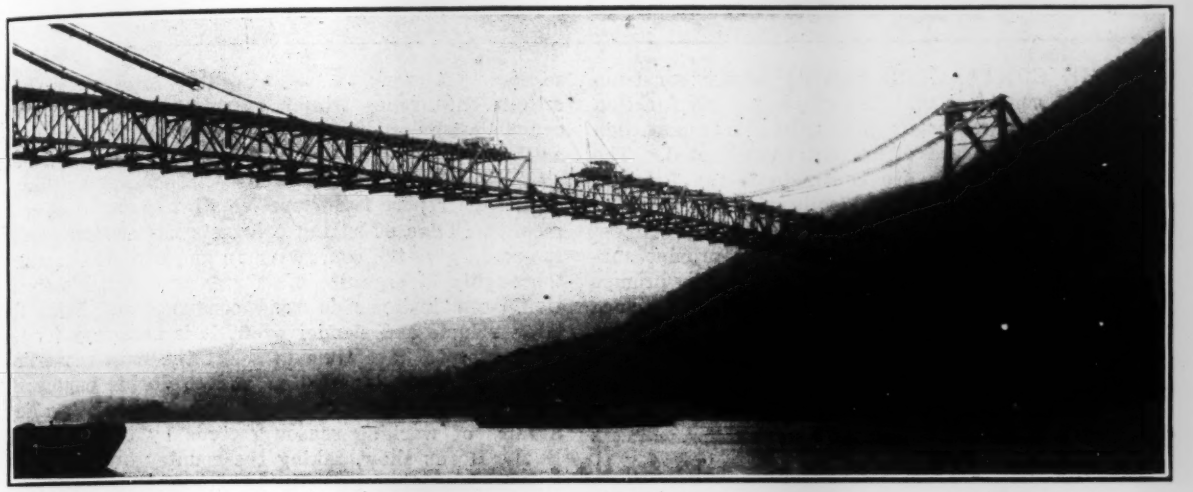


FIG. 2—BOTTOM CHORDS OF STIFFENING TRUSS ABOUT TO BE JOINED

Fig. 1 shows castings in position; the height is 11 ft. and the width shown 9 ft., flaring to 22 ft. behind the rock.

The eyebars are of structural steel and the bearings of cast steel. The main truss members are of silicon steel, furnished under special specifications, and the

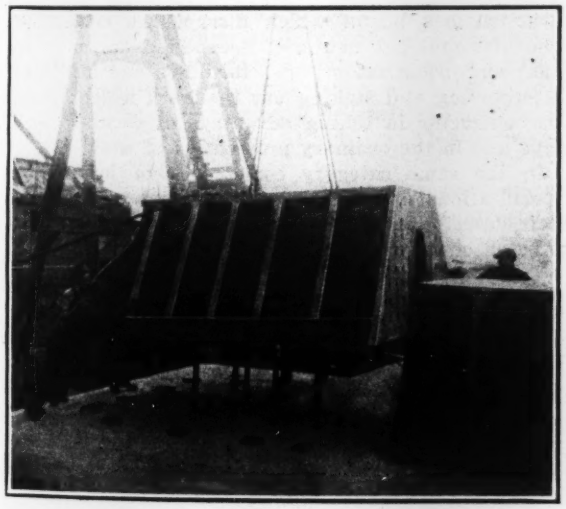


FIG. 3—SETTING CASTINGS ON PIER

floor system, bracing, towers, and approach spans are of structural steel according to A. R. E. A. specifications. The main trusses are attached to the towers by swinging vertical members, which pass through and are supported on a very wide truss on the main towers, so that the reactions are perfectly central.

The towers, which are 351 ft. high, rest on cast steel bases 10 ft. x 35 ft. x 5 ft. high, which in turn rest on concrete piers 20 ft. x 40 ft. on top. Each base is made up of three sections as is shown in Fig. 3. The columns are slightly battered transversely, so that the main trusses and the approach span trusses may come entirely inside, the width at the bottom being 89 ft. 10 in., and at the top 61 ft. 4 in., or the distance c. to c. of cables.

The main cables are of drawn steel wire and are 18¼ in. in diameter, each cable being made up of 7,252 galvanized wires which are of 0.192 in. diameter; the total length of single wire in the two cables being 7,377 miles.

The work on this structure was taken up early in 1923, the excavation for the anchorages and main piers being begun in May, and concreting for the latter starting early in August. The erection of the east tower started Oct. 22, 1923, both east and west towers being completed about the middle of April, 1924. The first castings were placed in the anchorage pits the latter part of January, 1924, and the anchor bars completely placed about June 1. Meanwhile, the wire rope cables for the temporary footbridge or working platform were put in place during April, and the platform completed early in June, thus enabling the spinning of the main cable strands to start on June 14. The cables were completed on Aug. 23 and immediately thereafter the weight of the footbridge was transferred to them and the wire rope cables removed, to be used for the main span suspenders.

Erection of the stiffening trusses started Sept. 13, the lower chords, web members, bracing, and the greater part of floor being placed by a traveler on each half of span advancing from the towers to the center of span and picking up the steel from barges towed to position. The travelers are now retreating shoreward and placing top chords and remaining floor members required to complete the span.

The structure was designed and is being supervised by Howard C. Baird, consulting engineer, 95 Liberty St., New York City.

Winter Construction

As the Contractor Regards It

IV. CO-ORDINATE SERVICES

Winter production and delivery of materials and full engineering co-operation are essential to success.

The Last of a Series of Four Articles

By C. S. HILL
Associate Editor, Engineering News-Record

AS THE CONTRACTOR regards winter construction, he considers that he can develop his function fully only when materials production, transportation and other services are effectively co-ordinated. The chief of these services are contractual—the function of the owner and engineer in facilitating the work of the contractor through uniform contracts and practices; by properly timing contract lettings; by prompt surveys, plans, etc.; by giving full information; by prompt payment. These affairs being adjusted so as to reduce his handicap, the contractor will meet the physical obstacles of materials supply, transportation and construction with confidence and can guarantee successful winter construction with certainty.

WINTER CONSTRUCTION CAMP IN NORTHERN MINNESOTA

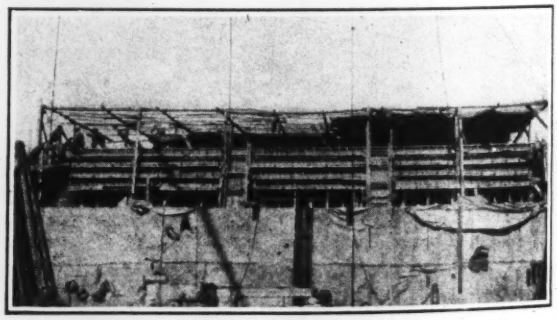
Contractual Service—Uniform contract requirements and construction practices would ease the contractor's task as a winter contractor. This is particularly true where work is of a public nature and as widely extended as is road building. There is variation in the temperature or time when concreting must stop in different states; in some states concrete paving with the engineers' consent and at the contractor's risk is permitted in cold weather and other states absolutely prohibit cold weather operations. Something of the same conditions prevails in other construction but least probably in building because of the general adoption of the standard contract of the American Institute of Architects now, with some modifications, the standard of the Joint Conference on Standard Construction Contracts. In every instance these vagaries of opinion and practice discourage the inclination of the contractor toward winter work. Contract requirements and construction practices uniform within practicable limits constitute a co-ordinate service considered desirable by the contractor for winter construction.

Timing contract lettings so that the contractor can schedule his work to take advantage of seasonal conditions encourages winter operations. It can be accomplished by study of seasonal labor and price records as they exist already or may be determined by building congresses and contractors' associations. The Hoover committee report is instructive with examples of such records. Time of letting contracts has another aspect. It should give the contractor an ample period in which thoroughly to organize his forces and plan his operation. An instance is road construction. With the large volume and slender profit it is necessary for the contractor to have time to select the most economical equipment and plant layout and to do his buying; to start winter stock piling and, perhaps, heavy grading. Studies of working season records by the Bureau of Public Roads show, taking the country over, irregular and time-wasting practice in prosecuting road work. Studies of time of letting contracts would encourage and aid contractors to correct this condition.

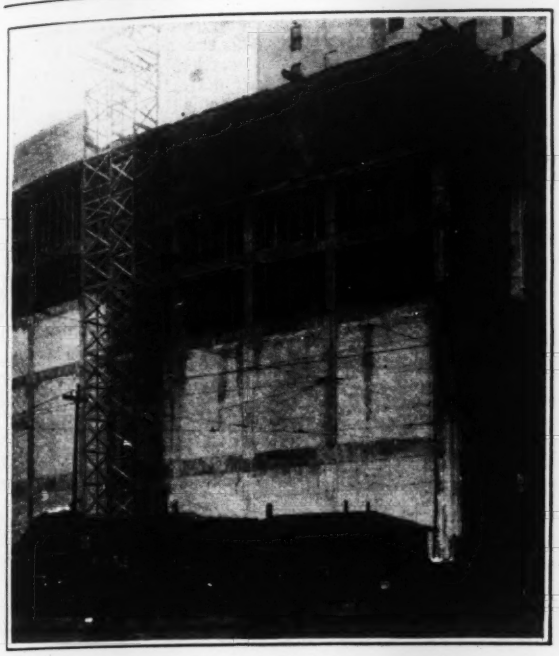
Poor engineering service handicaps the contractor undertaking winter work. This fault takes the forms most commonly of: (1) Limited finances for engineering or haste in starting construction imposed upon the engineer by the owner which prevents complete plans in ample detail necessary for the contractor to plan ahead intelligently; (2) changes in plans after construction has begun which disrupt the contractor's schedules and put new and unexpected duties on his plant and organization; (3) tardiness and inaccuracy in surveying and staking out the work which hamper the contractor in taking advantage of weather conditions and in the ordinary prosecution of work.

In the same category comes lack of information. Specifications are too often vague and incomplete in their description of materials and of conditions likely to be encountered.

Tardy estimates and delayed payments hamper the



TEMPORARY HOUSING FOR FOREBAY OF MINNESOTA POWER PROJECT



HOUSING CONCRETE MATERIALS ESSENTIAL IN WINTER BUILDING

contractor on a very considerable proportion of his work. Besides correcting this condition the owner and the engineer can aid the contractor in planning winter work by allowing estimates on accumulated materials.

While all construction at any time is hampered by these adverse practices wherever they prevail, their effect on winter work is greater because it calls for special methods and more exacting direction. A report of the committee on methods of the Associated General Contractors in discussing seasonal construction pertinently says: "Delays in engineering and architectural offices in approving estimates, furnishing details promptly, making decisions and assuming responsibility therefor should be eliminated or modified by provision for arbitration. The time of the contractor consumed in fighting these paper battles deprives the job of just that much more supervision and prevents the contractor from keeping his shoulder at the wheel of technical supervision."

Materials Supply—The problem of materials supply takes on emphasized importance in winter construction. Under present conditions winter production of virtually all construction materials is curtailed. This is due in the great majority of cases to lack of demand but in some instances cold weather hampers production. Weather is an important factor in sand and gravel production and an influence in quarrying and brick making. Sand and gravel production from water deposits or washed sand and gravel production is impracticable in winter as a general proposition. Finally, wet sand and gravel cannot be shipped without freezing in the cars. Commonly, for this reason, the railways will not accept wet sand and gravel shipments in winter. In a lesser degree cold and water affect crushed stone and brick delivery, particularly in shipment by inland streams.

For the most part, if winter consumption warranted the effort, means could be found to provide any construction material, even sand and gravel, for winter work. Indeed, now, some sand and gravel producers and more crushed stone plants are putting up summer stock piles for winter delivery. Shelter, heating and other winter protection methods are practicable in pit and quarry and in fact in a few instances are being employed. Under present conditions of only occasional winter construction the contractor can get readily and in adequate quantity all construction materials. With winter construction becoming general, an improvement in the winter production conditions would be needed.

Materials Delivery—Storm is more likely to interrupt railway service in winter. This places upon the contractor the need of greater storage so that work may not be stopped if, for a few days, rail deliveries should cease. On the other hand cars are usually more plentiful in winter and traffic is not so congested by other shipments. This is particularly true now when winter operations are only occasional. In general the contractor can anticipate better average railway deliveries in winter, his difficulties lie rather in unloading and job haulage.

Machinery has materially reduced the winter difficulties of unloading. It is, however, a machine job. So, too, is job haulage in winter. Cranes and power unloaders are the effective means of unloading frozen materials and maintaining operations in frost and storm. Haulage in winter with snow and frost to make the roads bad is a task for service railways and good tractor and motor truck equipment. With considerable hauling distances to and about the operation, materials delivery becomes an outstanding winter operation calling for special planning and outfits.

Conclusions of the Series
Winter Construction—as the Contractor Regards It

In this examination of leading factors of winter construction the contractor's function has been kept at the front. Let it be repeated that the contractor has an individual viewpoint which no one else, not even the engineer, so clearly has. The contractor's concern is close and specific and not as is that of all others remote and general. Let us keep the main points clear:

1. Winter conditions which affect the contractor are not climatic generalizations but local weather and frost phenomena, to be counteracted by specific methods.

2. Equipment and methods have been developed to a degree of efficiency which enables the contractor to solve the technical problems of winter construction with remarkable certainty.

3. Under present conditions of slack construction in winter, with labor and materials seeking a market, the contractor can obtain winter costs as low as or lower than the average costs of summer work. As all-the-year operations become general the present wages and price curves will flatten out and the savings will be reduced.

4. Co-ordinate development of materials supply and delivery are essential as the volume of winter construction increases.

5. Full and considerate co-operation of the owner and engineer with the contractor in easing the exactions of winter work will increase the contractor's efficiency and reduce his costs.

6. Present conditions of seasonal construction are not primarily of the contractor's making. He is the servant of the owner and can act only when the owner calls for action. His efforts individually and through organization are being actively directed toward eliminating seasonal construction.

Poor Design of Engineering Work Condemned by Court

Appeals Court Confirms Verdict for Contractor in Suit Over Laying of Outfall Pipe of Passaic Valley Sewer

INADEQUATE engineering design is sharply condemned in a decision just rendered by the U. S. Circuit Court of Appeals for the Third Circuit, at Philadelphia, in affirming a decision of the federal district court rendered in March, 1923, in a damage suit of John C. Tierney, contractor, against the Passaic Valley Sewerage Commissioners of New Jersey, for whom Tierney had contracted to build a sewer outfall under New York Bay by laying concrete pipe on the bottom of the bay. The Appeals Court holds that the work shown on the plans and called for by the specifications could not be built to give the desired result, and therefore affirms the decision of the lower court awarding the contractor damages of $183,481.53, including the profits he would have made had he been permitted to complete the work.

Tierney entered into the contract with the sewerage commissioners on Dec. 6, 1913, and was to complete the work about three years later. It comprised furnishing and laying 4,500 ft. of concrete pipe on the bottom of the bay, most of this pipe being 96 in. in diameter and the remainder ranging down to 24 in. In June, 1917, the work being still uncompleted, the commissioners declared the work abandoned and canceled the contract, upon certification by the commission's chief engineer that the work had been unreasonably and unnecessarily delayed and that the contractor had abandoned it.

Difficulties had been encountered almost from the start of the contractor's work, first in making tight joints between the sections of pipe, and later in supporting the pipe on the bay bottom. The decision says:

> The contract provided that after each section of pipe had been forced into permanent position with the adjoining section by hydraulic or other power, the space between the flanges should be calked by drivers with oakum and 2½ in. of lead wool, the lead to be calked into both the interior and exterior portions of the joint. The pipes were then to be tested by hydraulic pressure of 3 lb. per square inch and if the leakage in a 100-ft. length of pipe should exceed a quarter of a gallon per hour for each foot of pipe, the joint shall be recalked and such other additional measures taken as may be necessary to reduce the leakage to within the limit. During the year 1914 the contractor laid 13 of the 96-in. straight pipe on the north line, but not one successful test was secured by merely calking the joints in the manner provided in the contract. The contractor resorted to various expedients to reduce the leakage to within the required limit. He tried covering the joints with clay. Pine wedges were used. The joints were surrounded with concrete collars and the oakum was soaked in a tar preparation known as "Hydrex." None of these measures proved effective and several witnesses called by the plaintiff testified that the design of the joints was fundamentally defective and that nothing that the contractor could have done would have overcome the faulty design and made the joints tight. There was no denial of the testimony.
>
> The other difficulty encountered had to do with supporting the pipes. The contract provided that the pipes should be laid on blocks consisting of 6x12-in. sound spruce timber 7 to 9 ft. long. Wedges 12 in. long of 4x4-in. spruce were to be placed on the blocking to hold the pipes in position, and "any blocking that has been sunk too deep shall have additional blocking placed upon it to support the pipes at the required elevation." This method proved effective as to a portion of the pipe that was laid, but as the work progressed and extended to the 84-in. pipe on the north line it was found that the bottom was too soft to support the blocks, the undenied fact being that over a considerable portion of the area in which the pipe was to be laid the bottom of the bay at the prescribed grade consisted of so-called Hudson River silt, a soft material of a consistency about equal to that of thick soup. Here again several witnesses called by the plaintiff testified that it was utterly impossible to support the pipe throughout that area at the prescribed grade by blocks, and there was no denial of this testimony.

The judges of the appeals court hold that the contract implied a warranty that the calking of the joints if properly done would produce a tight pipe line and that blocking as specified would give satisfactory foundation.

> Tierney repeatedly called the defendant's attention to the inadequacy of the calking and the blocks to make the joints tight and support the pipes, and urged the defendant to adopt other methods. The answer always was that the calking if properly done and the blocks if properly laid would accomplish the desired results, and in response to the plaintiff's suggestion that piling should be used for a support he was told that he could use piling if he wished to, but at his own expense.

The clause in the contract (and similar provision in the bidding form) which stated that the contractor had carefully examined the location of the proposed work, and that he should have no claim if the character of the work or the nature of the soil proved different from that indicated or expected, or if unforeseen difficulties developed, is dismissed by the court as having no bearing on the question.

> This is no answer to the proposition that the prescribed method of supporting these pipes was blocking and that if any blocking sank too deep the prescribed remedy was additional blocking. This clearly involved a warranty that whatever the bottom consisted of, blocking would be adequate to support the pipe.

An incidental feature of the suit and of the decision is a claim bearing on the method of measuring the length of pipe laid. The contractor claimed that the vertical and horizontal branches should be included in computing the length of pipe (for which he was to be paid at the rate of $85 per linear foot). Under the contract, the commission's engineer was to determine the amount of the several kinds of work, etc. The court says that this clause "'vested him with authority to make measurements, but not to determine what was to be measured," and holds that the question at issue must be decided by the custom of the place where the contract is made and performed. Evidence had been introduced to show a trade custom under which branches are measured, and the decision therefore finds in favor of the contractor on this point also.

Another point in which the court decision limits the authority of the engineer bears upon the engineer's certification that the contract had been unreasonably delayed and abandoned. The defendant insisted in court that "there being no evidence of fraud, the engineer's certificate was conclusive and binding on the plaintiff." The decision says:

> Whether the plaintiff had unnecessarily and unreasonably delayed, depended upon whether the defendant had warranted the sufficiency of the plans and specifications and whether there had been a breach of any such warranty. Certainly this contract conferred no power upon the defendant's engineer to decide whether such a warranty existed. It did exist as a matter of law, and the evidence of its breach was convincing and undenied. As was said in McAndrews vs. Tippett, 39NJL105, "To have held, according to the insistence of the defendant, that any delay occasioned by his own acts or omissions could be made a ground for avoiding the contract against the will of the plaintiff would have been to permit the defendant to take advantage of his own wrong."

From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Floating Concreting Plant for Pier Does Rapid Work

RAPID progress in concreting with a floating plant is reported as a notable feature in the construction of the 1,700-ft. north breakwater at Ludington, Mich., to replace an old timber structure. There are about 4½ cu.yd. of concrete per lineal foot of breakwater, but owing to uneven settlement of the cribs the total amount poured was approximately 7,730 cu.yd. The work was done in sections, each consisting of two base blocks containing about 2.4 yd. of concrete and one cap containing 2.1 yd. All concrete work is reinforced.

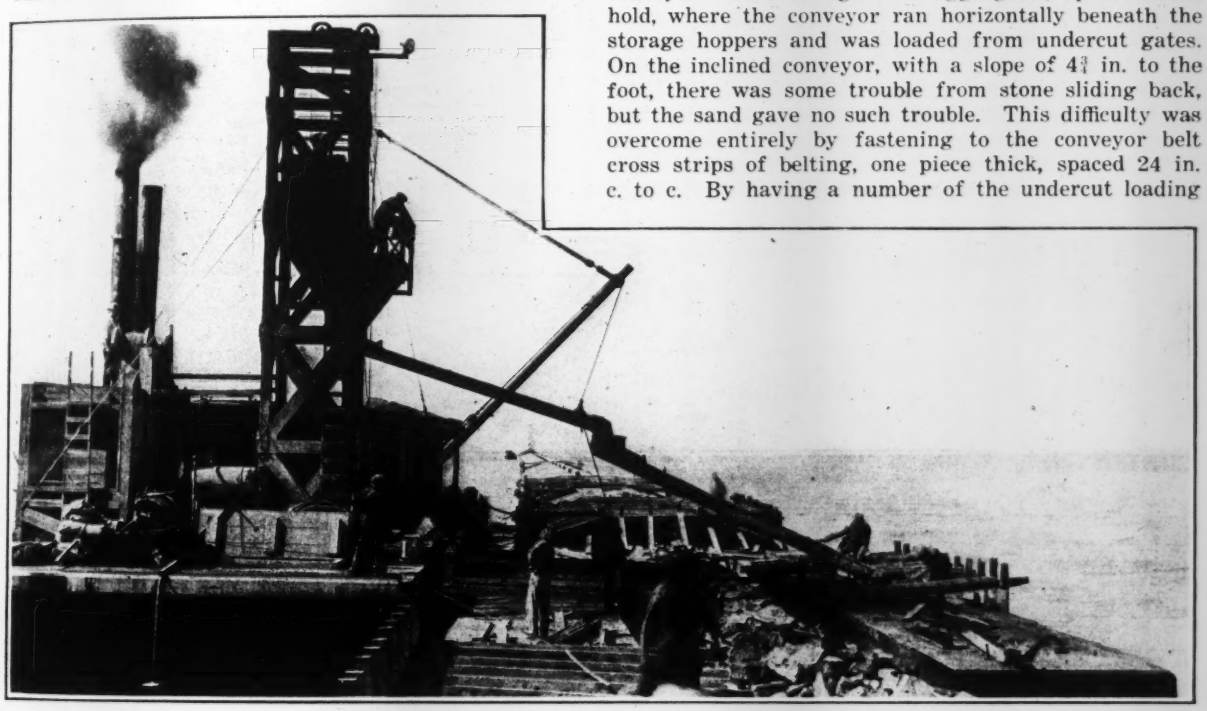


FIG. 1—CONCRETING PLANT AT LUDINGTON, MICH.
Entire storage, conveying, mixing and delivering operations handled on one scow. Sand and stone carried to mixer hopper by belt conveyors.

When the contract was awarded in December, 1923, the contractor had no marine equipment, and it was necessary to build a floating mixer plant, a floating derrick, floating supply bins, a floating carpenter's derrick and a tug. On April 26, the work of wrecking the old wooden structure was started and on June 2 the first pouring was done; the work was completed by Sept. 1 which is considered very fast time for work of this character.

This rapid work was made possible primarily by means of an ingenious and efficient floating mixing plant, which consisted of a 28-S mixer, two sets of storage bins, a belt conveyor to carry aggregates from the large bin to the mixer, and a skip hoist with spouting system. The mixer was located at one end of the scow and placed so that the operating platform was flush with the deck and the water tank was conveniently above deck. Over the mixer was a large supply hopper having two compartments and a total capacity of 5 cu.yd. Undercut gates allowed material to pass into the regular mixing hopper, the latter being marked so as to enable the operator to charge the exact amount of material for each batch.

The supply hopper was fed from an inclined belt conveyor which brought the aggregates up from the hold, where the conveyor ran horizontally beneath the storage hoppers and was loaded from undercut gates. On the inclined conveyor, with a slope of 4¾ in. to the foot, there was some trouble from stone sliding back, but the sand gave no such trouble. This difficulty was overcome entirely by fastening to the conveyor belt cross strips of belting, one piece thick, spaced 24 in. c. to c. By having a number of the undercut loading gates the contractor was able to keep the floating plant properly ballasted to avoid listing which would have put the mixer and the rest of the plant out of alignment. These storage bins had a capacity sufficient to supply aggregate for approximately 250 yd. of concrete and were divided into two compartments. After the concrete was mixed, it was discharged into a skip hoist and

CONCRETING AT LUDINGTON BREAKWATER

Length of Run, Hours	No. of Runs of this Length	Concrete Placed Per Run, Cu.Yd.
2	3	28.70 to 59.31
2½	10	29.05 to 114.00
3	10	103.70 to 155.55
3½	11	123.15 to 166.56
4	6	147.68 to 185.81
4½	2	148.03 to 150.15
5	1	203.30
5½	1	207.40

was spouted directly to the work. The average crew required for the entire job was as follows:

1 man to operate undercut gates to feed belt conveyor.
1 man on top of supply bin to divert flow of sand and stone into their proper compartments.
1 man to operate gates under supply bins and control the quantity of flow into the regular mixer hopper.
1 man for charging cement.
2 men carrying cement.
1 man to control discharging of mixing and water supply.
1 man on tower.
1 man to operate skip hoist.
1 fireman.
1 foreman.
3 men on the forms for puddling and placing steel.

From Job and Office

Hints that Cut Cost and Time

3-in. pump (supplying water to the mixer and keeping the scow drained), two deck winches for maneuvering the scow, a deck winch to operate the skip hoist and a turbo-generator for lighting purposes. Materials taken from stock piles were transferred to the storage hoppers on the mixing plant by a 15-ton floating derrick with a 70-ft. boom and ¾-yd. clamshell bucket. The

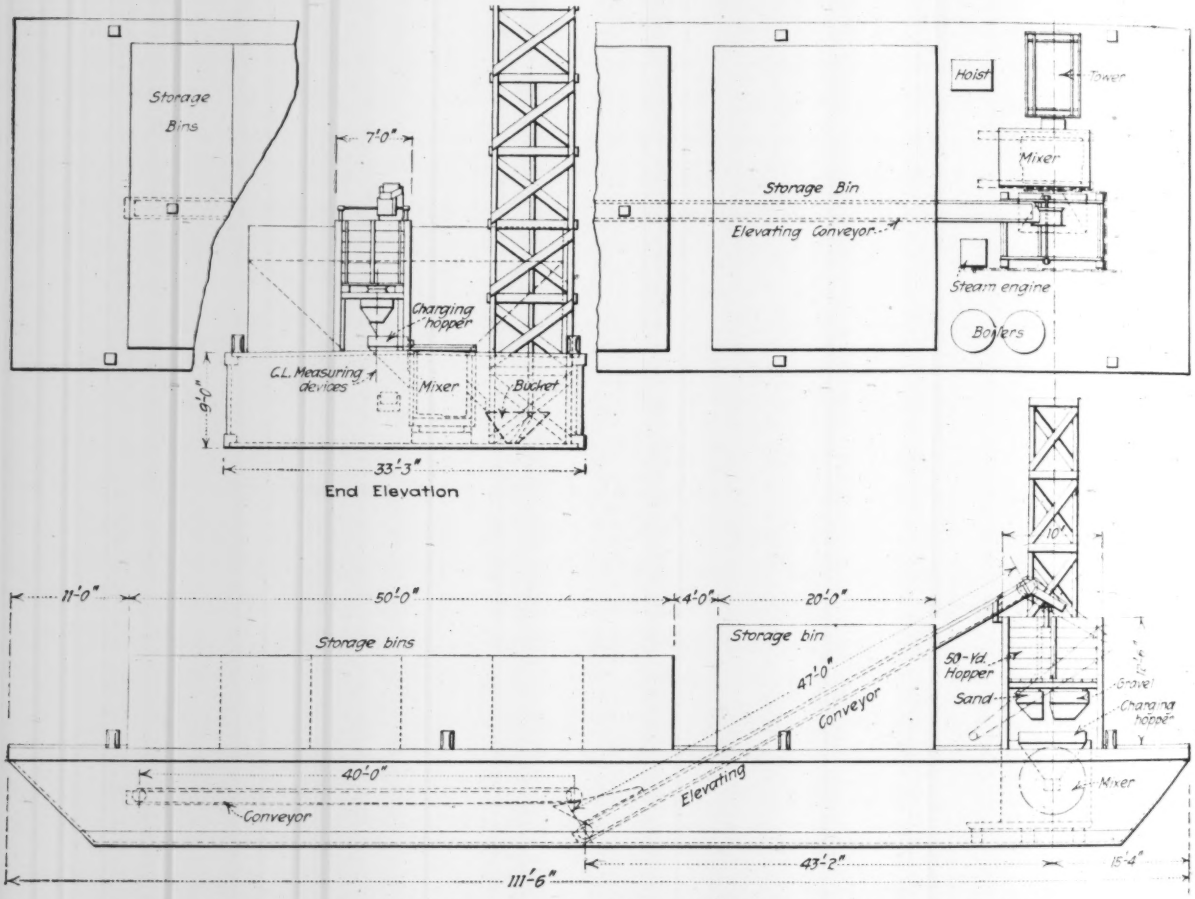


FIG. 2—FLOATING CONCRETE PLANT WITH CONVEYORS TO HANDLE MATERIALS

With this crew and equipment, the contractor was able to turn out concrete without any delays and the accompanying summary of the log indicates the speed at which the work was done. The mixing run included all moves of the mixing plant, and it was frequently necessary to make as many as six moves in one mixing period. Each of these moves would take approximately 10 to 15 minutes according to the wind conditions. In spite of working in open water it was practicable to get batches at intervals of approximately 80 seconds, each batch consisting of five bags of cement with aggregates which were proportioned for a 1:2:3 mix of concrete.

Two 40-hp. boilers and two 12-hp. engines drove the mixer and conveyor and also furnished power for a mixer plant was loaded at night and brought out to the job at daybreak, so as not to interfere with the speed of construction operations. All materials were brought to the job by lake steamers and were unloaded on the government dock in the harbor to be transferred to the mixer plant.

The S. M. Siesel Co., Milwaukee, Wis., had the contract for this work, which was done for the War Department under the direction of the district engineer, Major Gilbert Van B. Wilkes, Corps of Engineers, U. S. Army. The above information was furnished by the Siesel Co. and by the Chain Belt Co., builder of the Rex concrete mixer. F. A. Anderson was superintendent in charge for the contractor, on this Ludington breakwater work.

From Job and Office

For Contractor and Engineer

Bridge Contractor's Derrick Car

IN THE large steel derrick-car for heavy bridge erection, shown in Figs. 1 and 2, both the boom and A-frame are adjustable for length. The boom, of box lattice construction, has a 40-ft. permanent section to which 10-ft. and 20-ft. extensions may be added to give boom lengths of 50, 60 or 70 ft. For the maximum length the hoisting capacity is 10 tons on a radius of 50 ft.; with the 40-ft. length, the capacity is 30 tons on a radius of 30 ft. The boom has a maximum swing of 45 deg. to each side of the center line. Its head is of the elephant-head type, carrying two triple-sheave blocks for the hoisting falls. Eyebars pivoted in the head carry the topping-lift falls, which are led through sheaves on the A-frame and then down to the deck.

FIG. 1—BRIDGE-ERECTING DERRICK CAR

The mast or A-frame is normally 21 ft. 7 in. high above the rails, but its vertical posts have 3-ft. removable sections to reduce the height to 18 ft. 7 in.; this arrangement has been found very desirable in working through the portals of old bridges where the clearance is not up to present standards. With the mast thus lowered, its 2¼-in. stay cables are attached to a lower anchorage, as shown. For heavy side lifts, outriggers can be swung out to a total spread of 16 ft., timber struts 12x14 in. being placed from the outrigger to the A-frame. With this arrangement the car can handle its maximum loads at 13 ft. from the center line of the track.

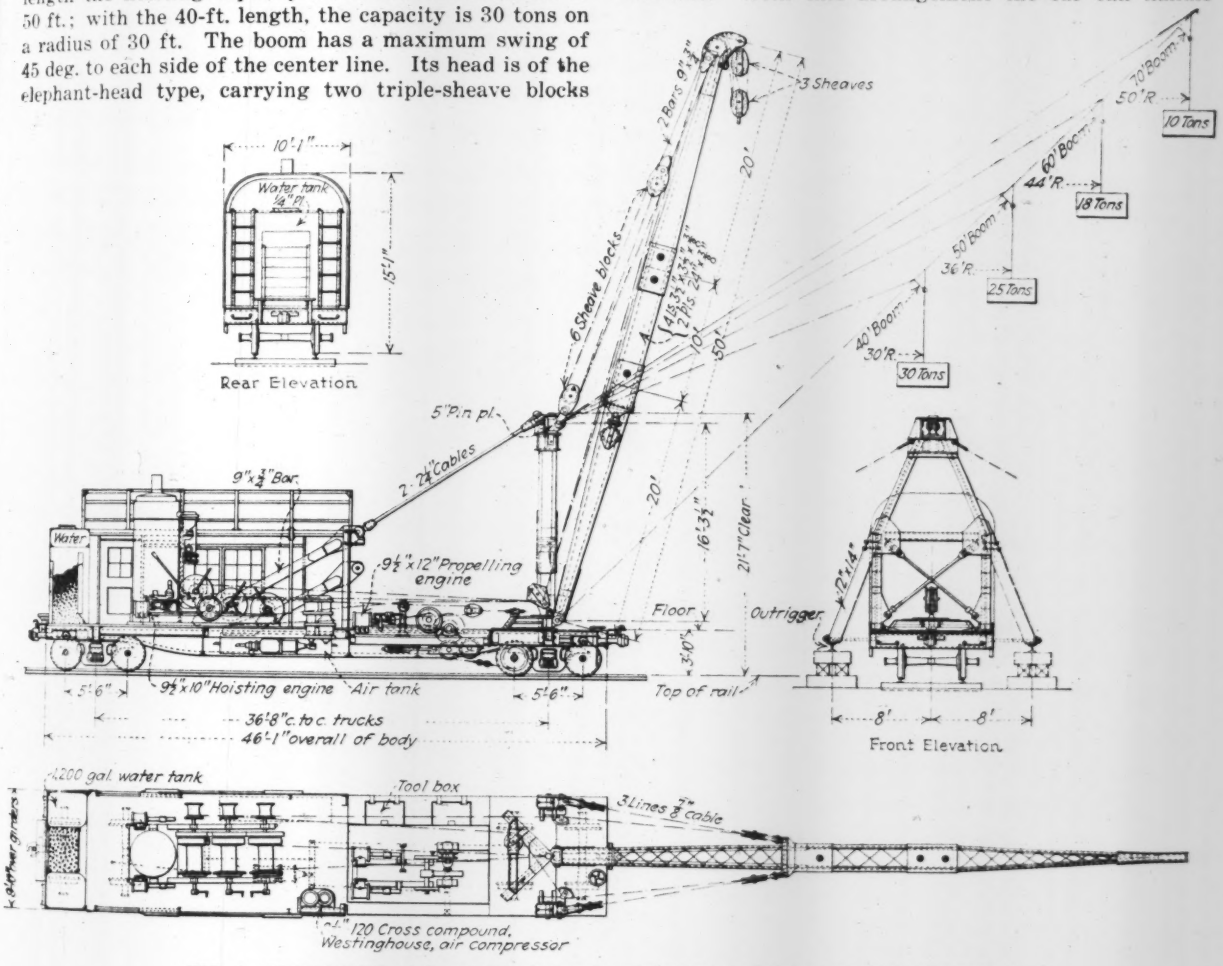


FIG. 2—ELEVATION AND PLAN OF STEEL DERRICK CAR FOR BRIDGE ERECTION

Steel construction is used throughout, with a checker-plate floor. The large cab contains a vertical boiler, feed-water heater, feed pump, cross-compound air compressor and a 40-hp. three-drum hoisting engine with a winch or niggerhead on each drum shaft. This engine handles the hoisting, topping and swinging lines, the last being attached to the head of the 40-ft. length of boom. The compressor not only serves the air brakes but also riveting hammers, drills and other portable tools on work which does not require the provision of an

independent compressor plant. A propelling engine on the deck is geared to a chain drive for the rear axle of the front truck, giving a speed of 18 m.p.h., so that the car can be run by its own power and also used to switch cars. It has actually handled trains of nineteen loaded cars. At the rear of the cab are a 2-ton coal bin, and 1,200-gal. water tank, giving ample supply for a day's work.

The machine is mounted on steel-frame trucks with 33-in. car wheels and has the standard equipment requisite for being hauled in trains or run over the road by its own power. Its weight in working order is about 68 tons. This derrick car was designed and built by the Kansas City Bridge Co., Kansas City, Mo.

Trucks Haul Plums Directly Onto Dam

IN THE construction of the Weid Canyon dam roads were built in the canyon walls so that for a considerable part of its height the top of the dam would be accessible to motor trucks. Thus plums for the concrete were hauled directly onto the dam in trucks and after being dumped onto the nearest concrete which had set, were moved thence by laborers to freshly placed concrete.

Work on the Weid Canyon dam, which is being built by the city of Los Angeles as part of its water distribution system, is under the general direction of William Mulholland, chief engineer of the Los Angeles Bureau of Water-Works and Supply.

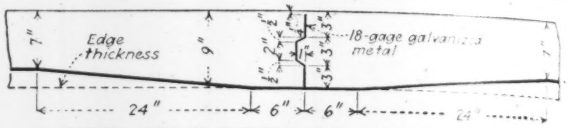
Strengthened Tranverse Joint for Concrete Roads

CONTRACTION joints placed approximately every 300 ft. are the practice in building concrete roads in Ohio. In recent road building, and for the future, a locked-joint construction has been worked out, as shown by the accompanying drawing, to reduce vertical slippage. As will be noted the Ohio practice is to thicken the slab at the edges after the manner developed in Illinois and now followed in a number of states. The new design calls for a similar slab thickening at the edges formed by a transverse contraction joint. The drawing leaves very little that requires to be explained.

With the tongue and groove metal strip forming the joint and with the edge thickening, the new construction is expected to hold the two sides of the joint true and even and to stiffen the slab against edge breaks. The extra concrete is 6¼ cu.ft. per joint, and for an 18-ft. slab the joint strip weighs 30 lb. Put in as shown, the joints cost $5 each and there are 18 joints to the mile.

From Job and Office

Hints that Cut Cost and Time



CONTRACTION JOINT, OHIO CONCRETE ROADS

An increased smoothness of road has resulted from the new construction.

L. A. Boulay is director of the Department of Highways and Public Works of Ohio and G. F. Schlesinger is chief engineer.

Neglect of Small Highway Bridges

BY S. E. BERKENBILT

Structural Engineer, Chicago

A TYPICAL case of the indifference often shown by officials of small communities to the condition of structures under their charge is that of a village in Illinois having a two-span truss bridge. This bridge was built in 1899; at some later date a street car line was laid on one side of the roadway and in 1906 a concrete floor was laid, adding much to the dead-load.

In 1921, the Village Board was advised that the structure did not appear to have adquate strength and the board requested a local steel company to make an inspection and to report its findings. This request, as is usually the case with small communities, was with an understanding that should repairs be necessary at a later date, the steel company would get the contract. No special sum was allotted for an actual investigation of the structure. The writer, who was engaged by the steel company for the purpose of inspecting the bridge, was instructed to carry his examination only to the extent of reporting actual "visible" defects that must be corrected, no effort being made to investigate the stresses or detail condition of the bridge. The inspection disclosed the fact that the bridge was badly in need of repairs. The increased dead-load due to the concrete floor, together with the present heavy automobile traffic, a factor undreamed-of years ago, have most likely contributed to the overstressing of the structure. Other conditions, such as the familiar kicking into the end post by trucks, have also taken place on this bridge, and finally a complete absence of painting to preserve from rust have all contributed to the present state of the structure. The following is an extract of the report of inspection of the bridge to the village clerk:

A number of bridge members above the roadway show marked signs of deterioration due to rust, which in some cases has completely eaten up the metal, forming irregular holes. The end shoes show distinct signs of overload, the webs and flanges of the shapes composing them being distorted. The grillage beams under the shoes are completely overstressed; flanges and webs are distorted from original position and also unsuitable for long service.

The writer pointed out in his report that the structure was approaching a dangerous state and recommended that an investigation of the bridge be made immediately to determine the status of the structure. The Village Board, however, requested the steel com-

From Job and Office

For Contractor and Engineer

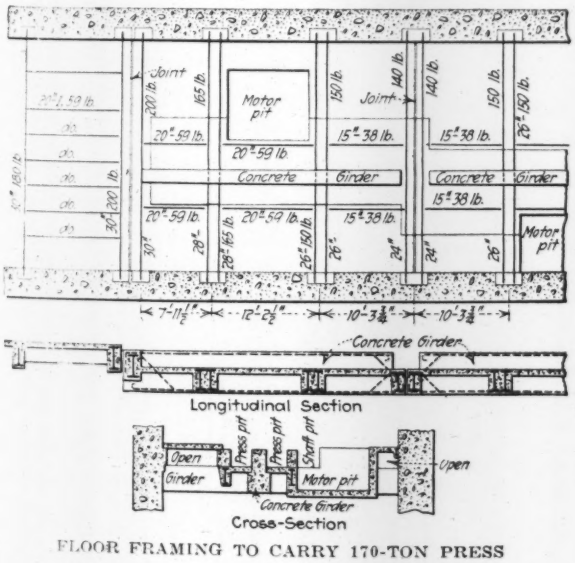
pany to quote a price on repairing the bridge complete, which it was impossible to do without a thorough detailed examination. The repairing of the individual members would call for considerable skill and ingenuity, but only a small amount of material would have been used. However, the total cost of this work would only be a small fraction of the cost of a new structure, and the required quotation given to the Village Board was an offer to carry out the contract on a percentage basis, with the customary charges for engineering service and contractor's profit. Nothing has been done in this matter, and it is evidently assumed that there is plenty of time before attention need be directed to the safety of the bridge.

Printing-Press Floor Stiffened by Concrete Bridging Girder

BY EDWIN S. PARKER
Structural Engineer, Boston

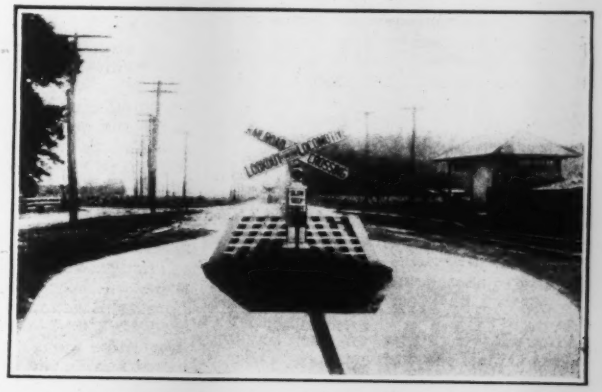
A CYLINDER press is a very exact machine. Any slight variation in alignment and the type may not touch the rolls exactly, so that portions of the sheet will not print. Besides, a shaft running the whole length must not bind. The problem of alignment of a press on a beamed floor might be simple if it were not for the fact that at one time there may be one roll of paper on the end of the press and at another time seven rolls or more, and each roll weighs 1,400 lb., which will cause varying deflections in the floorbeams and put the press out of line. Moreover, the floor must stay true during erection, when the loading is very uneven.

At the plant of the Boston *Post* a double octuple press weighing 170 tons was to be set on a floor that spanned 30 ft. Short headroom prevented the use of deep fabricated sections, so we used the largest girder beams that could be evenly proportioned to the various loads, all being chosen about 75 per cent over-strong. For binding the floor together into an integral whole, short bearing walls in the middle of the press pit, required for the bed plate of the press, were joined to form a large concrete girder the whole length of each press. This formed very rigid bridging for the steel beams. A joint was put at each end of each girder, cutting the press floor apart from the adjoining sections of floor. In this way, each press was on a sort of boat that might pitch endwise a minute amount but would always be in exact alignment. When the press was erected, even the most critical mechanic could find no trace of deflection; the press works perfectly.



FLOOR FRAMING TO CARRY 170-TON PRESS

Grade-Crossing Protective Device



AN EXPERIMENT in grade crossing protection is being carried out at Cool Spring, on the Delaware Division of the Pennsylvania R.R., according to the *Pennsylvania News*, through the cooperation of the division officials and C. D. Buck, engineer in charge of highway construction for the State of Delaware. The device for protecting the crossing consists of an obstruction erected in the center of the highway at each side of the track and 25 yd. back from it. The paving of the highway is turned out sharply at each side of the obstruction and then drawn in again before reaching the crossing. This makes it necessary for motorists to reduce their speeds considerably before they reach the crossing.

The standard crossing sign, a flashing signal, and a colored reflecting glass are set up on the center line of the highway at the obstruction. In addition, lattice work, painted black and white, is built in between the two concrete blocks which form the outer ends of the obstruction.

Job and Office Notes

X-Rays Have Been Successfully Used in building alteration work at Schenectady, N. Y., in ascertaining the location of pipes and timbers within the floor. This information the contractor obtained quickly, without disturbing the structure, by the use of a new portable X-Ray apparatus which, with an operator, was placed on the floor of the room below. An observer in the room above examined the floor with a fluorescent screen by means of which the pipes and timbers were seen distinctly. To use this apparatus it is only necessary to connect an ordinary extension cord to the nearest socket of the house circuit; X-Rays are then produced by pressing the switch. Since the outfit is in a metal container within a leather-covered wooden case, there is no high-voltage hazard. The outfit is grounded to the container. With the specially designed transformer and tube the entire apparatus is mounted in a box about 6½ x 10½ x 8¾ in. and weighs only about 20 lbs. This new apparatus has been developed by Dr. W. D. Coolidge at the laboratories of the General Electric Co.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

News Brevities

An Allotment of $100,000 to be expended in the further improvement of the upper Mississippi has been made from the river and harbor appropriation by the Chief of Engineers.

Apparently the Department of Justice has placed the entire controversy with regard to trade association statistics in cold storage until after the election. The strong stand taken by the American Federation of Labor opposing undue limitation of trade association activities is expected to discourage any demagogic attacks on this type of business activity.

After Having Blocked the Sabine-Neches Canal, the waterway connecting Beaumont and Orange, Texas, with the sea, the wreck of the Italian steamship Isondzo was raised by the Corps of Engineers after unusual difficulties. The vessel burned and sank in such a position as to block the channel entirely and to make extremely difficult the matter of its removal. The cost of the operation will exceed $30,000.

Action On the Part of the Dominion Government in putting into effect the agreement recently arrived at with E. W. Backus respecting the control of the water levels of the Winnipeg River has been delayed until the return to Ottawa of Premier Mackenzie King, who is making a political tour in the West. The Government of Manitoba is strongly opposed to the terms of the agreement and has forwarded a statement of its objections.

Contracts for Work Totaling $4,795,-407.11 have been let by St. Louis, Mo., under the $87,372,500 municipal bond issue voted in February, 1923, according to a report submitted by E. R. Kinsey, president of the Board of Public Service, to the citizens bond issue supervisory committee. On the contracts awarded a total of $1,751,061.21 actually has been paid out. The amount of money appropriated by ordinance is $7,852,209.88, while $12,000,000 of the bonds have been sold.

The Government of the Province of Quebec has decided on the erection of a re-inforced concrete bridge over the falls of the Montmorency River and has announced a competition for the best design, open to all civil engineers of the Province having had at least five years' experience. Two prizes of $1,000 and $500, respectively, are offered, the successful designer to have the superintendence of the work for 5 per cent of the cost. Plans are to be submitted not later than Jan. 12, 1925.

A. R. Hirst Made Chief Engineer of American Vibrolithic Corp.

A. R. Hirst, for seventeen years chief engineer of the Wisconsin Highway Commission, and who resigned several months ago to enter the primary election for governor of that state, has been appointed chief engineer of the American Vibrolithic Corporation, of Des Moines, Iowa. Mr. Hirst severed his connection with the Wisconsin department to carry his fight for good roads to the people direct, feeling himself more capable of administering the broad aspects of highway work as the state's chief executive than as the chief engineer of the state highway department.

Though defeated in the primaries he polled a large vote. Hereafter Mr. Hirst will devote his entire time to the technical and engineering features of vibrolithic concrete pavements and bases and to the service of the corporation's clients.

During his twenty-two years of professional service Mr. Hirst has served three states in highway engineering work, first in the highway division of the Maryland Geological Survey, then the Illinois Highway Commission and finally that of Wisconsin.

Mr. Hirst is past president of the American Association of State Highway Officials, to which office he was elected in 1912, and has been a prominent figure in the deliberations of that association for years.

In announcing the association of Mr. Hirst with the Vibrolithic corporation a statement from that concern reads:

"The corporation has secured the services of Mr. Hirst in order that it may give its clients the best available engineering services, and in order that vibrolithic concrete pavements and bases may be, if possible, further improved in value and permanency."

Missouri Bank Protection Plan May Be Revised

A new basis for local co-operation for bank protection work on the Missouri River will be worked out in the near future, it is believed, as a result of a conference in Kansas City between General Harry Taylor, Chief of Engineers, and the representatives of the local interests.

Heretofore the local interests have been contributing seventy-five per cent of the cost of the work intended primarily for land protection. The point now has been reached where the protection work has been completed at practically all points where the land is sufficiently valuable to permit of co-operation at that rate. In order to provide protection for the additional areas consideration is being given a per-acre charge.

Pennsylvania Plans New Philadelphia Station

Site Is on West Bank of Schuylkill—Present Terminal To Give Way To Commercial Development

Special Correspondence

Announcement has been made by the Pennsylvania R.R. of plans for a new station in Philadelphia, together with extensive changes in the railroad property in the central portion of the city. It is proposed to locate the new station in the area between the west bank of the Schuylkill river and Thirtieth St., between Market and Arch Sts. The station is to be planned for eighteen tracks each having 1,500-ft. platforms for through trains, and in addition eight tracks and platforms, at a different level, for suburban traffic. This makes a total of 26 tracks as compared with the present Broad St. station with only 16 sub-end tracks.

An underground station is to be constructed west of Fifteenth St. and just north of the present Broad St. station to be used as a central station terminal for suburban trains. Connecting this underground station with the new Philadelphia station will be a subway of four tracks constructed under Filbert St. and crossing the Schuylkill River by a new bridge to the level of the suburban lines in the main station.

Will Remove Elevated

When the changes in the railroad structures have been made, the elevated tracks east of the Schuylkill River will be removed and the area occupied by them will be made available for commercial development in Philadelphia. The present Broad St. station will be demolished, except for the office building portion, which will be remodeled.

Along with construction of the subway to the central part of the city, the Pennsylvania R.R. plans electrification of all its suburban services out of Philadelphia.

It is proposed that a central boulevard 80 ft. in width shall be constructed over the railroad subway tracks, extending from the end of the Parkway to the river front of the new station on the west bank of the Schuylkill River.

It is stated by railroad officials that work on the new station may be started next year and that the entire project could be completed in five years.

The plans for changes in the railroad location and property are in accordance with the proposals made recently by the city for the replanning of central Philadelphia. These proposals involve, in addition to the railroad work, street widening, changes in the city subway locations, and the construction of a subway street and concourse beneath the city hall. The proposals for city replanning were outlined in *Engineering News-Record*, Aug. 7, 1924, p. 237.

Administrative Board of A.E.C. Meets in Chicago

Active Campaign for Public Works Department Decided Upon—Many Topics Reviewed

Return to the plan of government reorganization embodied in the Jones-Reavis bill, originally sponsored by the engineering profession, was decided upon at a meeting of the administrative board of the American Engineering Council at the headquarters of the Western Society of Engineers, Chicago, Oct. 17. The resolution adopted by the Board follows:

"Resolved, that the committee on government reorganization as it relates to engineering matters of the American Engineering Council be instructed to adopt a policy of aggressively working for the complete project of the Department of Public Works as outlined several years ago."

The committee, of which Gardner S. Williams of Ann Arbor, Mich., is chairman, will, it was announced by President James Hartness, who presided, work with other organizations in allied fields and submit a comprehensive report at the next assembly of the Council, which will be held in Washington, Jan. 16 and 17, 1925.

Action on Reclamation

The board discussed exhaustively the question of reclamation and adopted a resolution carrying out the recommendations of Executive Secretary L. W. Wallace contained in the following report:

"The special advisory committee, appointed by Secretary Work, to make a study of the Bureau of Reclamation, made a most complete, constructive and far-reaching report. This report and the proposed legislation growing out of it should be carefully studied by a special committee of American Engineering Council for the purpose of determining what line of action, if any, the American Council will pursue with relation to the matter.

"It is an important engineering question that will be widely discussed and considered by government officials, Congress, and others in the immediate future. The executive secretary earnestly recommends that a special committee on reclamation be appointed at once to study the question for the purpose of formulating a course of procedure for American Engineering Council and to pursue such a course when and if approved."

The board voted its opposition to the Cramton Bill, which would place the control of industrial alcohol in the hands of the Prohibition Unit. The Council thus supports the position taken by the American Chemical Society and the American Institute of Chemical Engineers. The resolution sanctioned by the board endorsed the attitude taken by the Institute.

The board voted to send the Interstate Commerce Commission with its approval resolutions submitted by the American Society of Agricultural Engineers regarding wooden sleeping cars as a result of the death in a railroad accident near Chicago on June 30 of Frederick Walter Ives, president of this society, and other prominent engineers. It was that same accident which proved fatal to John H. Dunlap, secretary of the American Society of Civil Engineers. The resolutions said:

"Resolved, that this protest be laid before American Engineering Council with the recommendation that that body as the federation of leading organizations of engineers of the country, formally protest, on behalf of engineers of all classes, to the Interstate Commerce Commission against the further use of wooden Pullman sleeping cars between steel sleepers, and, further that the complete abandonment of the use of wooden sleepers as early as feasible be strongly urged."

Appointment of engineer members to the board of Tax Appeals, set up by Congress to hear complaints of taxpayers against the rulings of the Collector of Internal Revenue, was urged by the board. The board adopted a report of its patents committee urging them in Congress the prompt passage of bills H.R., 9221 and S. 3363 for the purpose of raising the salaries of the federal judges, or other bills. The report of the Coal Storage Committee, now available in published form, was finally sanctioned. The Topeka Engineers' Club was admitted to membership. A proposal to appoint a member of a committee of the American Construction Council to further better building was declined.

The board voted to invite the Founder and other national societies to cooperate in compiling an authoritative and comprehensive pamphlet on the compensation of engineers. A committee will be formed to direct the work.

Conference of Secretaries

A conference of secretaries of engineering societies will be held in Washington on the day preceding the annual meeting of the assembly. A committee of five engineering society secretaries will be named to develop the program for the conference.

Action of the executive secretary in requesting engineering societies to consider the proposal to form a World Federation of Engineers was approved. This action was taken at the request of Dr. Sykora, president of the Engineers' and Architects' Association of Czechoslovakia.

A proposal that the Council withdraw from participation in the work of the National Board for Jurisdictional Awards was referred to a special committee. Reports of officers were approved, and much minor business transacted. The outlook for progressive development of the Council was described by President Hartness as encouraging.

Two joint meetings with the engineers of Chicago supplemented the board's sessions. At a noonday meeting at the Auditorium Hotel, the speakers were President Hartness, Fred R. Low of New York, president of the American Society of Mechanical Engineers, and F. K. Copeland of Chicago, past-president of the Western Society of Engineers.

Report on Dayton Bridge Failure Submitted

Harrington, Howard and Ash Find Structure Unsuitable for Heavy Truck Loads

Failure of the Summit St. bridge over Wolf Creek at Dayton, Ohio, while heavily overloaded, was reported in *Engineering News-Record* of Aug. 7, 1924. Immediately after the collapse the firm of Harrington, Howard and Ash, of Kansas City, was engaged to investigate this failure and report on it. This report was made to City Manager F. O. Eichelberger under date of Sept. 22. It states that the bridge failed while two heavy trucks were crossing; one truck, carrying sand and gravel, weighed from 12 to 13 tons; the other, carrying coal, weighed 3½ to 4 tons.

The following extracts are from the "Summarized Report and Conclusions" of Harrington, Howard and Ash:

"The trusses were of a type known as inverted bow-string with straight top chords of I-beams, connecting at their ends to curved lower chords of eyebars, with vertical posts, and two diagonal bars in each panel. At each upper chord panel point a single U-bolt served to connect all members.

"The breakage of one of these upper chord U-bolts was the primary cause of the collapse. The stresses induced in the U-bolts by the loads on the span were more than twice safe working stresses, and exceeded the elastic limit, or yield point, of the material.

"There is credible testimony that one of the diagonal bars was lying on the floor of the bridge alongside the east truss a half hour before the collapse, and the position of this bar since the collapse tends to verify the observation. This bar could have fallen down only by the breakage of at least a portion of its connecting U-bolt. The remainder of the U-bolt would then have failed when stresses were induced by the trucks causing the collapse. That the collapse was primarily due to the weakness of the upper chord U-bolt connections is equally true whether the diagonal bar dropped down one-half hour before or at the time of the accident. The resulting collapse would have been a fraction of a second sooner, in case the U-bolt failed in two operations, but otherwise just the same as if the U-bolt had failed all at one time.

"With loads similar to the truck crossing the span collapse had been imminent from failure of the floor system. For certain positions of wheel loads, some of the floor stringers were stressed above their elastic limits, and were at the point of failure. . . .

"In general the material, which is substantially all iron, appears to be in fair condition and fairly well preserved as far as painting is concerned. Different fractured bars disclosed defects, particularly in the welded parts, most of which probably existed from the time the bars were first produced. These welds, however, did not contribute directly to the collapse. . . .

"The structure never was suitable for carrying heavy truck loads. . . ."

Chicago Sanitary District Review Board Organized

Organization of 28 Consultants Into Ten Committees Effected—Earnest Study Begins

Sitting for a full week the twenty-eight sanitary and hydraulic experts called in from all over the country to review the program of the Sanitary District of Chicago in regard to Chicago's sewage disposal and diversion of water from Lake Michigan, organized themselves into ten committees to study and review as many subjects. Adjournment was taken Oct. 18 and the next session will be in Detroit, Oct. 24, during the meeting of the American Society of Civil Engineers. In the meanwhile, certain groups visited the regulating works at Sault Ste. Marie, while others remained in Chicago to view in detail portions of the works of the District not covered in the general inspection. This latter included trips on Oct. 13 to the Calumet treatment plant and Sag Channel, Oct. 14 to the Wilmette pumping station at the head of the North Shore Channel, the completed Maywood and partially constructed $13,000,000 North West Side activated-sludge plants, and Oct. 15 down the main drainage channel to the controlling works and power plant at Lockport.

INSPECTION TRIP MADE

Through the courtesy of Edward J. Kelly, chief engineer of the District, who is also president of the South Park Commission, the waterfront improvements of the park, involving a large acreage of fill behind tight bulkheads were inspected. Mayor Dever and Col. A. A. Sprague extended to the commission all the facilities of the city administration and particularly referred to the prevention of the enormous waste of water as a factor they would like to have considered.

F. C. Shenehon, consulting engineer, explained in detail the proposed budgeting of the waters of the Great Lakes, with the necessary regulating works and the effect of the several diversions in Canada and the United States. Langdon Pearse, sanitary engineer, developed the sanitary program and outlined the data on which it was based. Dr. F. W. Mohlman, chief chemist, described the analytical work of the district and control of the disposal plants. H. P. Ramey, assistant chief engineer, described the hydraulic features of the Sanitary District development and its effect on the Illinois River. Other speakers included Dr. W. A. Evans, health editor, Chicago *Tribune*, and Dr. Herman N. Bundesen, city commissioner of health, on health conditions in the District; John Ericson, city engineer, on the Chicago water-works system.

Organization of the Engineering Board of Review of the Sanitary District of Chicago's Lake Lowering Controversy and Remedial Program (the official title) was effected Oct. 16, with the following officers: E. E. Haskell, dean emeritus, Cornell University and formerly member of the International Boundary Commission, honorary chairman; George W. Fuller, chairman; Paul H. Norcross, secretary.

Topics for consideration, with personnel assignments, are as follows, the first named being chairman:

1. Summary, history of international negotiations on lake level diversion—E. E. Haskell, George W. Fuller and F. H. Newell.

2. Lake levels, effect on shipping and lake regulation—John R. Freeman, C. E. Grunsky, J. F. Hasskarl, Robert E. Horton and Arthur E. Morgan.

3. Value of water for transportation in lakes-to-gulf and other projects—Francis Lee Stuart, George G. Earl, John B. Hawley, Arthur E. Morgan and Col. C. S. Riché, U. S. A.

4. Power development of the Sanitary District and potential development downstream; effect on power; comparison of power at Niagara and St. Lawrence with Chicago; time factor of power development; ability to market; value in different localities — Robert E. Horton, Richard R. Lyman, Col. J. L. Ludlow, Paul H. Norcross and Francis Lee Stuart.

5. Reversal of Chicago River and Calumet River; runoff frequency; reversal with various flows; capacity of channels; velocities, etc.—Prof. S. M. Woodward, Prof. John H. Gregory, John B. Hawley, Clarence W. Hubbell, and Morris Knowles.

6. Dilution method, reasonable dilution ratio; suitability of local application; what other cities are doing; significance of industrial waste; sewage treatment program—Harrison P. Eddy, James H. Fuertes, Prof. John H. Gregory, T. Chalkley Hatton, Clarence W. Hubbell, Dean Anson Marston and A. E. Phillips.

7. Relation to water supply; public health aspects—George W. Fuller, George H. Fenkell, Wynkoop Kiersted, Paul H. Norcross, Ezra B. Whitman, W. W. DeBerard, Col. J. L. Ludlow.

8. Economics; financial aspect and past cost; probable funds to be made available for future work—Col. C. S. Riché, W. W. DeBerard and H. E. Phillips.

9. Reasonable program for construction —Morris Knowles, George G. Earl, T. Chalkley Hatton, George H. Fenkell and Harrison P. Eddy.

10. Balances of equities and conveniences —F. H. Newell, John R. Freeman, C. E. Grunsky, Dean E. E. Haskell and Dean Anson Marston.

While no limiting date has been set for bringing in a report, the District officials have expressed a desire to have the report before the holidays, so that the findings may be available for the use of the Congressional waterways committees before which hearings have been held on the several bills calling for 10,000-sec.ft. diversion.

Welland Canal Contract

Six of the eight sections of the Welland Canal in Canada, are now under construction and tenders have been called for work on the seventh section between Welland and Hamberstone. Plans for the eighth section between Welland and Port Robinson will be ready for the calling of tenders early next year. It is also expected that tenders for the superstructures of several of the bridges across the canal will be called for in the near future.

Refuse Grinding and Incineration Plant for Lyons, France

A project for a refuse grinding and burning plant, with heat utilization for the production of power for use in municipal abbatoirs, refuse collecting trucks and with the use of clinker for making brick or concrete, has been approved by the city council of Lyons, France. The estimated cost is 17,000,000 francs (say $1,000,000), which has been provided for in a municipal loan of 117,000,000 francs already authorized.

American Falls Reservoir Cost Paid In

Idaho Water Users Hand Check for $1,989,316 to Secretary Work—Bids Opened on Monday

Completion of plans for the construction by the government of an immense reservoir at American Falls, Idaho, to furnish additional water to irrigate approximately 1,500,000 acres of land in the Snake River Valley was announced by Secretary Work of the Interior Department Oct. 16 after a check for $1,989,316, closing the deal for the big undertaking, was handed to the Secretary by a delegation of Idaho business men headed by Senator Gooding. The money represents the payment of the share of the cost of the reservoir to be borne by the American Falls Reservoir district. It is one of the largest checks ever paid the Government for such an enterprise.

The reservoir's construction is the first step on a large scale taken to carry into effect the recommendations made by the Special Advisory Committee on Reclamation providing that in the future the management of reclamation projects be in the hands of water users' associations and districts instead of the government. Construction of the dam has been thrown open to competitive bids which were opened Oct. 20 at American Falls, Idaho.

The cost of the reservoir when completed will amount to $8,000,000. It will be 25 miles long, 12 miles wide with an average depth of 40 ft. and will hold 17,000,000 acre-ft. of water. The additional water supply furnished the farmers throughout the valley is expected to enhance the crop production by approximately $40,000,000 annually. The production of beet sugar alone is expected to be increased by 7,000,000 sacks a year, which will double the operation of eight sugar-beet factories in the valley that have been running only half time.

Both the American Falls Reservoir District and the Empire Irrigation District raised the money to pay their share of the construction of the reservoir through bond issues.

Special Body To Study Camden-Philadelphia Transit Needs

A special committee consisting of five members of the Delaware River Bridge Joint Commission has been appointed by the Commission to study the transit needs and means of providing transit facilities over the Delaware River Bridge connecting Philadelphia and Camden. The members of the committee are Thomas B. Smith, chairman of the executive committee of the Delaware River Bridge Joint Commission; Samuel M. Vauclain and Richard Weglein, Pennsylvania members of the commission; and John B. Kates and Frank L. Suplee, New Jersey members of the Commission.

The Philadelphia Rapid Transit Co. has made an offer to the bridge commission to operate transit lines over the bridge as part of the unified transit system of the city of Philadelphia.

Asphalt Road Conference Held at Louisville

Stability Test Apparatus Proves Most Interesting—Comparability of Types Discussed

Engineering News-Record Staff Report

The third annual conference of asphalt roads was held under the auspices of the Asphalt Association at Louisville, Ky., Oct. 13-15. About 150 attended the conference including representatives of the asphalt industry, highway and city engineers and asphalt paving contractors. Following the welcoming speeches and the announcements of the purposes of the conference by J. R. Draney and J. E. Pennybacker, president and general manager of the Asphalt Association, there was a program of about a dozen listed papers and discussions.

A varied program of papers was offered, covering tests, sand-asphalt roads, gravel base, black base, resurfacing and maintenance. Of chief interest as indicated by the activity of the following discussion were the paper by Prevost Hubbard on "Research Looking to Improvement in Asphalt Paving Mixtures," and the paper by E. W. James, Bureau of Public Roads, on "Comparable Designs of Pavements." Mr. Hubbard touched a particularly responsive chord among the paving engineers present by his presentation of a simple stability test for asphalt mixtures and for mineral aggregates for asphalt mixtures.

Stability Test Described

Described briefly, the stability test apparatus developed by Mr. Hubbard consists of a hollow metal cylinder 2 in. in diameter into which fits a solid metal plunger. The top of the cylinder is open and the bottom consists of a removable portion 1⅝ in. in diameter and a fixed annular ring ⅜ in. wide. In operation the asphalt mixture is placed in the cylinder, with its bottom closed, and the plunger is forced down with a pressure nominally equivalent to that given by the regulation sheet asphalt road roller. By this procedure a briquet 2 in. in diameter and 2 in. thick is formed. This is the test piece. It is placed on the cylinder, with the 1⅝-in. bottom plug removed, resting on the annular shoulder. Pressure is applied through the plunger and the force is recorded at which the briquet begins to shear or flow through the bottom opening. It appears from the tests so far completed that the procedure described indicates closely comparative stability of mixtures.

The same procedure, Mr. Hubbard stated, has been developed so as to determine the comparative stability of sand mixtures without the asphalt touches or cement. In the sand test, however, the opening in the cylinder bottom is reduced to 1⅛ in. To hold the sand in shape, without material cementing action, castor oil was found the most satisfactory agglutinant. The tests of castor oil-sand mixtures have developed almost as promisingly as have the asphalt mixtures. Mr. Hubbard announced that the tests were going ahead and in a few months results could be given which would be of decided value to asphalt road builders.

In this paper on comparable designs Mr. James outlined the development of the procedure employed by the Bureau of Public Roads for determining comparable or equivalent designs of different road types. He argued the fairness of intention in the Bureau's methods and stated how it had come about naturally that the concrete road had become the base or datum to which all other designs are referred. The discussion was prolonged and all was to the end that comparable design was impossible between things so fundamentally different as road types.

Black base construction was the third subject of major attention. In the discussion considerable confusion appeared, many of the black base examples cited resembling structurally, resurfacing more than true black base roads.

The papers on highway financing by bonds, on shipping and unloading asphalt, on sand-asphalt roads, on concrete foundation mixtures and on maintenance disclosed only familiar theories and practices.

Hughes Opens Question of Power Diversion in Lakes Basin

Secretary of State Hughes, in a note transmitted to the Canadian Government under date of Sept. 10, though not given out to the press until Oct. 16, asserts that, in the matter of the engineering study to be made in connection with the proposed development of the St. Lawrence River, the United States "is not convinced that it would be wise to consider the power value of diversions from Lake Michigan without, at the same time, considering the power value of other diversions." Secretary Hughes states further, however, that "this government is prepared to instruct the American representatives on the Joint Board of Engineers to proceed with the consideration and investigation of the matters covered by the recommendations of the technical officers, with the exception noted, if the Canadian Government should be willing to issue similar instructions to its representatives."

Secretary Hughes proposes that the technical officers be instructed to consider further the controverted proposal, with a view to its modification in a form acceptable to both governments. Reading between the lines it is evident that Secretary Hughes is at a loss to understand why there should be objection to the simple finding of essential facts and he states in so many words that "the Government of the United States is quite willing to have the Joint Board of Engineers develop the facts with respect to any phase of the St. Lawrence problem, with a view of arriving at an equitable adjustment of the rights and interests of the two countries."

In addition to the Canadian diversion of 36,000 sec.-ft. at Niagara Falls, there also is the diversion of 1,000 sec.-ft. by Canada at the Welland Canal, in addition to several diversions at points along the St. Lawrence River.

Executive Board of A.G.C. Meets in Des Moines

Affiliated Bureaus and Code of Ethics Given Wide Discussion—May Change to "Constructor"

Discussion of affiliated bureaus, a code of ethics, the business outlook for 1925, and work accomplished during the past season, and the recommendation that "constructor" replace "contractor" in its corporate name, occupied most of the time at the three-day fall session of the executive board and the advisory board and president's council of the Associated General Contractors of America held Oct. 13-15 at Des Moines, Iowa. The sessions were attended by more than 70 members of the association, the largest number yet recorded at a board meeting.

It was decided that the next annual meeting of the A.G.C. shall be held in Washington, D. C., Jan. 12-14, at which time there will be submitted a recommendation to change the name of the organization to the Associated General Constructors of America, the term "constructor" being urged by Gen. R. C. Marshall, Jr., general manager, as more truly descriptive of the membership's functions than "contractor."

Affiliated Bureaus

Considerable time was devoted to discussion of affiliated bureaus of the A.G.C. through which means it is hoped to bring equipment manufacturers and supply men into closer co-operation with the association. This ambition has been realized fully in only one case, that of the concrete mixer manufacturers, although several other groups are favorably inclined. General regret was voiced that further progress had not been made, the reason being mainly the lack of personnel and funds to push the work. The Board approved the designation "Mixer Manufacturers' Bureau," for the group which has adopted the plan. The title will not be compounded with that of the Associated General Contractors, so that while the affiliation will exist and matters of mutual concern will be handled through the A.G.C., the mixer manufacturers will have an organization with an independent identity to take up subjects which concern them alone. On subjects of mutual interest, the action of the bureau and the officers of the A.G.C., approved by the board of the latter, will be final, without reference to the convention of the A.G.C. A similar plan will be followed with other affiliated bureaus subsequently organized.

An entire day was devoted by the board to discussion of a tentative draft of a code of ethics for general contractors. The suggestions placed before the board were gone into fully and a number of changes were approved. A redraft will be made in line with these changes and the committee in charge hopes to issue this in time to have it in the hands of members before the convention at Washington in January.

The outlook for construction business in 1925 is for a volume about the

same as this year and last year, board members reported. The consensus of opinion appeared to be that there will be some increase in material prices next spring, due to the continued heavy building program and depleted inventories by the producers of materials. Spotty increases in wage scales also are anticipated, but with the tendency to abolish the bonus system little or no increase in net labor costs is anticipated. As a whole, it was felt that owners will not have to pay much, if any, higher prices on contracts than they have paid this year.

Based on replies to questionnaires received from 505 members, Gen. Marshall reported to the board that members of the A.G.C. in 1923 performed construction work amounting to $1,828,900,000, of which 70 per cent was buildings; 14 per cent, public work; 8 per cent, highways, and 8 per cent, railways.

The subject of quantity surveys in estimating was discussed only briefly because of lack of time for more full exposition, but this matter is to be emphasized hereafter when opportunity affords. Board members were given copies of a pamphlet setting forth the system of quantity survey as practiced by the Milwaukee Chapter of the A.G.C. for their study. The results of a test at Denver were cited to the board. In this case, 16 contractors bid on four school buildings, for two only of which quantity surveys had been made. In the cases of those for which no quantity surveys were made the ranges between the highest and lowest bid were 15 to 20 per cent, while in the cases of those for which surveys had been made the ranges were approximately 5 per cent.

Bonding, standard contract forms and various other subjects were discussed in more or less detail.

The membership report showed a slight loss thus far this year, due to the policy of weeding out inactive members. The net position of the A.G.C., however, was reported as considerably stronger and by the time of the annual convention it is expected the membership will be equal in numbers to that of the year previous, but with all those shown on the books being active, supporting members.

Col. Geo. B. Walbridge is the official nominee for the presidency of the organization with H. W. Baum as vice-president.

Move Made to Improve Passenger Facilities at New Orleans

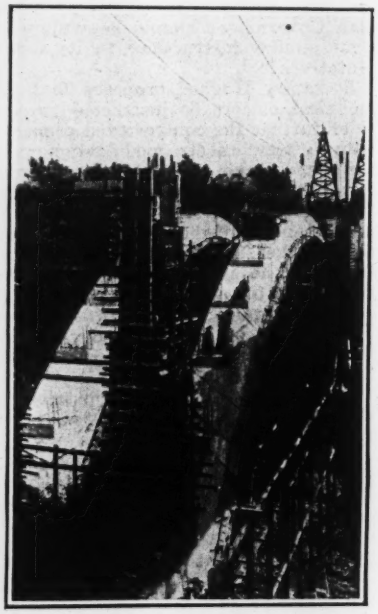
Formal notice to show cause why they should not provide "adequate depots and passenger facilities" in New Orleans has been served on the Louisville & Nashville R.R., the Illinois Central R.R., the Yazoo & Mississippi Valley R.R., the Southern Pacific, and the Gulf Coast Line by the Louisiana Public Service Commission. The Southern R.R., the Texas & Pacific R.R., and the Louisiana Rail & Navigation R.R., which have their own stations, are not included in the commission's order. It is anticipated that this order may lead to developing of a union station.

Arch Centering Struck on Jack's Run Bridge

Falsework for the 311-ft. reinforced-concrete arch of the Jack's Run bridge at Pittsburgh, Pa., was lowered Sept. 18 to 24, six weeks after the last concrete in the arch rings was poured. This new Allegheny County bridge connects North Side, Pittsburgh, with the borough of Bellevue.

The clear span of the arch is 311 ft. 7 in., the rise 71 ft. 10½ in., and the height of the crown at the intrados above the low point of the valley 140 ft. The crown thickness of each rib is 8 ft. and the thickness at the skewbacks 12 ft. 6 in.

The falsework for the arch was a combination of steel H-columns and timber. The steel column bents, 30 ft. c. to c., with posts on centers 10 ft., 22 ft., and 10 ft., respectively, braced with horizontal timber struts and tie-rods, rose from concrete pedestals in the valley to a height of about 90 ft. The bents were capped with heavy I-beams upon which blocks and wedges were secured. Above the wedges fan-type centering of timber bents with 12x16-in. caps supported 8x16-in. stringers upon which transverse 4x6-in. joists, wedged to proper curvature, carried 2x10-in. lagging.



JACK'S RUN BRIDGE, PITTSBURGH

The deflections at the crown were as follows: with structural steel reinforcing 0.075 ft., with concrete and steel 0.327 ft., progressive with column loads 0.35, and when the wedges were struck 0.42 ft.

Construction was started in March, 1924, and it is expected that the bridge will be completed in Feb., 1925. Norman S. Sprague is consulting engineer for the county. The John F. Casey Co., of Pittsburgh, is the contractor, S. L. Fuller, vice-president in charge, W. M. Byers, superintendent and Charles F. Bornefeld, resident engineer.

Random Lines

At Last This Problem Has Been Solved!

Sir—For some time the writer has been endeavoring to find in print a formula which will give the correct answer for the lateral resistance of piles. However, not being able to find one in print, he carefully compiled data from every job which would give any information, and has evolved the following formula, which is guaranteed to give the safe lateral resistance of piles under all circumstances.

Having used this formula successfully in his own practice for some time, he now takes pleasure in passing it on for the use of other members of the profession who have need of such a formula.

The formula is as follows:

$$R = c\left\{\frac{\left(\frac{2Wh}{s+1}+P\right)(s+2)-\frac{2Wh+P(s^2+3s+2)}{s+1}-2Wh}{(L+D+I)\frac{l}{b}}\right\}\left(\frac{E^2\alpha_w\alpha_s m^2}{r^2 s_s}\right)^{\frac{1}{3}}$$

in which

R = safe horizontal pull in tons.

W = weight of hammer in pounds (multiply by $\frac{s+1}{s+0.1}$ for steam hammer).

h = fall in feet.

S = penetration in inches at last blow (For jetted piles, assume penetration to refusal under 2-ton Tupp at 10 ft.)

P = dry weight of pile in tons.

L = expected live (variable) horizontal load in short tons.

D = expected dead (permanent) horizontal load in short tons.

I = fluctuating (vibrating) horizontal load in short tons.

E = modulus of elasticity of wood.

m = moisture coefficient of the soil = $\frac{\text{wt. of 1 cu.ft. of wet soil}}{\text{wt. of 1 cu.ft. of dry soil}}$ (Average of 10 samples)

l = length of pile in inches.

r = radius of gyration of pile 12 in. below butt.

d_w = specific gravity of wood.

d_s = specific gravity of soil.

c = constant for the type of soil under consideration, as follows:

for	sand (wet),	c =	0.432 to 0.576
	sand (dry),	=	0.678 to 0.930
	clay (wet),	=	0.243 to 0.325
	clay (dry),	=	0.427 to 0.566
	gravel	=	0.302 to 0.907
	hardpan	=	3.350 to 8.972
	solid rock	=	11.321 to 15.759

Yours very truly,
ENGINEER.

* * *

We've Got These On Our List.

"George Blood, who is our personal *typographical engineer* . . ."—From the title-page of *Business*, for October.

"Allen & Billmyre Co., Inc., *Pneumatic Engineers*"—From a *Power* ad.

"A *domestic engineer* would be a woman to advise architects, plumbers, home builders and possibly appliance manufacturers, on installations of gas from the woman's point of view"—American Gas Association Monthly.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Detroit, Mich., Oct. 23-25, 1924.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, San Francisco, Calif., Nov. 17-20, 1924.

ADVISORY BOARD ON HIGHWAY RESEARCH, Washington, D. C.; Annual Meeting, Washington, Dec. 4, 5.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Ill., Jan. 5-9, 1925.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Montreal, Jan. 27-29, 1925.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 24-27, 1925.

The National Municipal League will hold its annual meeting, Nov. 10-12, partly in Harvard Union, Cambridge, Mass., and partly in the Chamber of Commerce Building, Boston, and its program includes discussion of public improvement bonds, regional planning, municipal government and the government of metropolitan areas.

The Engineers' Society of Western Pennsylvania at its monthly meeting Oct. 23, William Penn Hotel, Pittsburgh, Pa., will have a talk on Water Power by T. O. Kennedy, vice-president and general manager of the Ohio Public Service Corporation, Cleveland.

Personal Notes

C. L. McKESSON, research engineer on the staff of the testing laboratory, has been appointed by R. M. Morton, California state highway engineer as the representative of the California Highway Department on the Advisory Board on Highway Research of the National Research Council.

D. E. GALLOWAY, assistant to Sir Henry Thornton, president of the Canadian National Rys., has been appointed assistant vice-president in charge of a number of subsidiary companies, principally electric lines serving territory in the neighborhood of Toronto and Montreal.

JOHN F. CHRISTOPHEL, secretary of the Department of Public Safety, St. Louis, Mo., has been promoted to the position of Director of Public Safety at St. Louis, following the resignation of JAMES N. McKELVEY who has assumed the presidency of the Clayton Quarry Co., St. Louis. Mr. Christophel was in the building department at St. Louis for thirteen years, serving as inspector, permit clerk, chief clerk and secretary. Upon his assuming the place as director of public safety, he appointed WILLIAM E. C. BECKER, who has been chief engineer of the building department, as building commissioner for the city.

GEORGE A. MOUNTAIN, Ottawa, Canada, chief engineer of the Board of Railway Commissioners for Canada, has resigned on account of ill health.

DR. YOSHYO KURATSUKE, a member of the technical staff of the Imperial University of Japan, is in Washington making a study of American methods of handling river and harbor work. Dr. Kuratsuke is a civil engineer who has been in charge of important work in Japan and Manchuria.

MAJ. R. G. McGLONE, U.S.A., retired, has been appointed harbor engineer for Long Beach, Calif. Major McGlone, who has been associated for several years with Col. Edward N. Johnson, consulting engineer in harbor work for Long Beach, is a specialist on jetty construction and harbor dredging work.

H. A. VAN NORMAN has been appointed city engineer of Los Angeles, Calif., succeeding John A. Griffin. Mr. Van Norman, who has been in the employ of the city about fifteen years, had charge of the construction of several sections of the Owens River Aqueduct, under the direction of William Mulholland, chief engineer of the Bureau of Water Works and Supply, and more recently has had direct supervision of the construction of the city's new outfall sewer.

J. E. PENNYBACKER, general manager, the Asphalt Association, will sail for England Oct. 27 on a business trip to advise with the British asphalt interests on problems of mutual concern to the British and American branches of the industry. Mr. Pennybacker will be absent about five weeks and will make a brief visit to the continent before returning to America.

ARNOLD RICHARDSON, assistant resident engineer with the California State Highway Commission, has resigned to accept a position with the Los Angeles city engineering department.

Obituary

ROBERT H. REID, Cleveland, Ohio, who for thirty-four years was supervisor of bridges, at Cleveland, for the New York Central Lines, Buffalo and West, died Oct. 16 at his home in Cleveland, aged 59 years.

HENRY ROBINSON TOWNE, engineer and manufacturer, president of the Yale & Towne Manufacturing Co. of Stamford, Conn., from 1868 to 1915 and since then chairman of its board of directors, died Oct. 15 at his home in New York City. Mr. Towne was born in Philadelphia in 1844 and was educated in private schools, the University of Pennsylvania and the Sorbonne in Paris; in 1919 he was given the degree of Doctor of Commercial Science by New York University. In 1868 the partnership with Linus Yale was formed, but Mr. Yale died within three months and Mr. Towne was president of the company from that time on. Mr. Towne was a past-president of the American Society of Mechanical Engineers. He was for six years president of the Merchants' Association of New York, was active in promoting the organization of the Chamber of Commerce of the United States and was made one of the first directors of the Federal Reserve Bank of New York.

CARL J. MELLIN, Schenectady, N. Y., consulting engineer of the American Locomotive Co. and designer and patentee of many locomotive devices and improvements, died at his home Oct. 16. Mr. Mellin had been closely identified with naval architecture and mechanical engineering in Sweden and Scotland and this country for many years, and had been knighted by the late King Oscar of Sweden for his achievements in the engineering field.

WILLIAM A. GARRETT, transportation manager of the Baldwin Locomotive Works and widely known engineer, died at his home in Philadelphia, Pa., Oct. 10 of pneumonia, at the age of 63 years. Mr. Garrett formerly was president of the Chicago, Great Western and the Seaboard Aid Line Railroads, and for several years was manager of the Philadelphia and New York divisions of the Philadelphia & Reading Ry.

WILLIAM RING, contractor, Ogdensburg, N. Y., died at his home Oct. 12 after several months' illness. Mr. Ring was born in Ireland in 1862. In 1888 he became superintendent on construction of the street railway at Asbury Park, N. J., and in following street railway work was manager at Lancaster, Pa., superintendent of the Paterson, Passaic and Rutherford Ry., superintendent at Fall River, Mass., and construction superintendent on a line at Scranton, Pa. Then he became a member of the firm of Lee, Ring & McDonald, of New York City, which handled highway, street and railroad contracts and among other things constructed a concrete dam on the Housatonic River at Glendale, Mass.

EDWIN R. GRAY, Hamilton, Ont., formerly city engineer of Hamilton, died Oct. 10 at his home in that city, aged 40 years; he had been ill a year. Mr. Gray was an engineering graduate of the University of Toronto and of McMaster University. His early professional work was with the Canadian Pacific Ry., on the Toronto-Sudbury line, later work was on the National Transcontinental Ry. Then he took up municipal engineering, and was assistant city engineer in Toronto from 1913 to 1915. In 1915 he became deputy city engineer of Hamilton, and city engineer the following year. A year ago, because of ill health, he retired from this work but was appointed manager of the Parks Board of the City.

A. ACHTERT, 53, assistant resident engineer with the California State Highway Commission, died while on duty on a grading project in the Imperial Valley.

From the Manufacturer's Point of View

A Point of Contact
Between Maker and User of
Construction Equipment and Materials

Diverse Uses Indicated for Truck Loaders

Examples Show Application to Road and Alley Grading, Snow Removal and Track Reconstruction

IN ADDITION to stock-pile loading many other rational uses for creeper-mounted truck loaders have been developed. The performances recited below are not "stunts," but are cases of every-day operation from the records of the George Haiss Mfg. Co., Inc., New York City.

Frenzel Bros. Co., Chicago, use two creeper loaders for grading alleys to be paved. The material is sand, ashes and spoil from cellar excavations. The alleys, 9 to 16 ft. wide, are plowed and large stones are removed by hand. The loader backs down the center of the grade and the sides are hand finished, the material being shoveled into the path of the feeding propellers. In one interval of 28 min. total elapsed time, one loader handled 40 yd. into 8 trucks.

Rogers & Monroe, Muskegon, Mich., use a creeper loader for grading streets before paving. The material is sand, and unless there is an old surfacing the streets are not scarified. The grading force consists of the grading foreman, the loader operator and one laborer. Ford trucks (1¼ yd.) are loaded at the side of the machine, and 15 to 18 were needed for an average haul of 1¼ miles. The daily average for the summer of 1924 was 290 cu.yd. measured in excavation. Gasoline consumption averaged 15 gal. per day.

The Roadway Department, New Orleans Public Service, Inc., uses a creeper for removing old shell and clay ballast on track reconstruction. When the material is moist the buckets and chute have to be cleaned from time to time, but even then economical operation is reported. A separately mounted belt conveyor discharges to the side. A 40-yd. work train has been loaded in 50 min. working time, and in one 8-hour day 112 2-yd. wagons have been loaded.

C. J. Mallett, Inc., New York, who uses two creeper loaders in his material yards, took one of them out on a snow removal contract last February. With the operator and two men cleaning up the snow outside of the feeding propellers, he loaded 8-yd. trucks regularly in 3 to 4 min. He made no changes in the loader for that work.

Triangle Sand Co., Mamaroneck, N. Y., tripled the output of a ½-yd. drag-line outfit by substituting 300 ft. of industrial track, a 2-yd. dump-car and a creeper loader with worm-operated swivel extension spout. One drum of the drag-line hoist hauls in the car which is returned by gravity. It takes 2 min. to load the car and 2 min. for the round trip. One track set-up cleans 45 ft. and the floor is left smooth for a future real estate development.

Roanoke-Webster Brick Co., Roanoke, Va., supplements its steam shovel with a creeper. Covered storage of clay and shale is built up for wet weather operation and the loader handles this storage and also rehandles outside storage in dry weather. Its operation is claimed to be satisfactory in dry clay and soft shale.

(1) ALLEY GRADING IN SAND AND ASHES. (2) STORING CLAY FOR BRICK MANUFACTURE. (3) GRADING STREET BEFORE PAVING. (4) LOADING SAND FOR DRAG LINE HAULAGE. (5) REMOVING STREET RAILWAY BALLAST OF SHELL AND CLAY. (6) LOADING SNOW INTO MOTOR TRUCK

Business Notes

PACIFIC FLUSH TANK CO., New York, announces that it has assumed charge of the marketing of the sewage and trash pump invented by A. B. Wood, of New Orleans, and used for several years in that locality. This patented pump is designed to handle water containing large solids without clogging, thereby eliminating the necessity of screening. The runner blades have blunt rounded edges so that trash, rags or paper will not lodge on them.

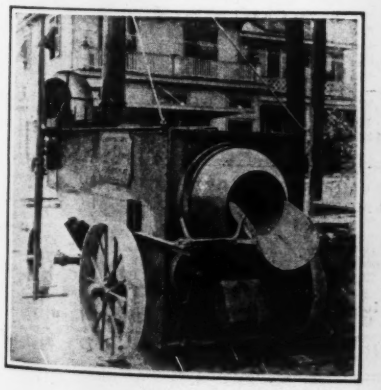
CHAIN BELT CO., Milwaukee, has announced the appointment of the Ginsberg-Penn Co., Inc., New York City, as distributor for Rex mixers and pavers for the eastern half of the State of New York. The distributing company has just moved to new quarters at 18 E. 41st. St., New York, where it will carry a stock of both mixers and parts and also maintain a service department. C. H. Ineson, formerly with the Chain Belt Co. in northern New York, has joined the Ginsberg organization. The George W. Whitehead Co., Buffalo, will continue as the representative of the Chain Belt Co. for the Western half of New York.

Equipment and Materials

Rotating Sand Heater for Paving Block Joint Mastic

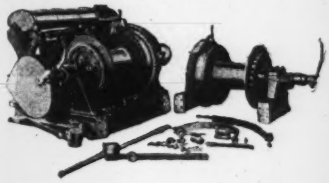
For heating and drying sand used for mixing with asphalt to form mastic joint filler for block paving the Acme Process Asphalt Grouting Co., Inc., New Orleans, La., is marketing a mechanically rotated heater consisting of a drum and firebox on a four-wheel mounting. The drum is rotated by a gasoline engine for which, if desired, an electric motor may be substituted.

The heater is of the continuous type holding about 6 cu.ft. of material, the construction being such that the hot sand is always at the front or discharge end. The device may be equipped to burn either cordwood or oil. To load the drum, sand is thrown in with a shovel while the scoop shown in the accompanying photograph is tilted upward. To discharge sand the scoop is lowered. The heater weighs 7,000 lb. and raises the sand to a temperature of about 400 deg. F.



Standard Hoist Equipped With Fordson Motor

A 20-hp. single drum gasoline hoist with provision for attaching boom-swinging gear when desired, operated by a Fordson motor, has just been announced by the S. Flory Manufacturing Co., Bangor, Pa. The machine is designed especially to meet the needs of contractors and quarrymen. Among the advantages pointed out by its manufacturer are economy of space



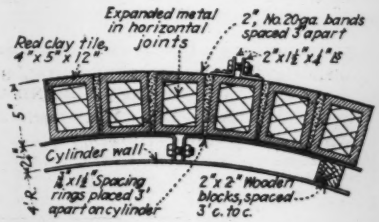
and light weight in proportion to the duty performed.

The engine operates at 1,050 r.p.m., giving a 4,000-lb. pull on a single line at 125 ft. per minute. The mounting is on wooden skids and the weight is 5,384 lb. for the single-drum and 7,398 lb. for the double-drum combination. The drum diameter is 12 in. and the width between flanges 20 in.

The hoist is a standard Flory unit with frictions of the cone type and brakes of the band type with asbestos woven lining designed to stop the drum in either direction of rotation. The over-all dimensions of the single-drum unit are 7 ft. wide, 5½ ft. long, and 5 ft. high; with the double-drum attachment the length is increased to 7 ft. 9 in.

Frost Casing for Steel Tanks

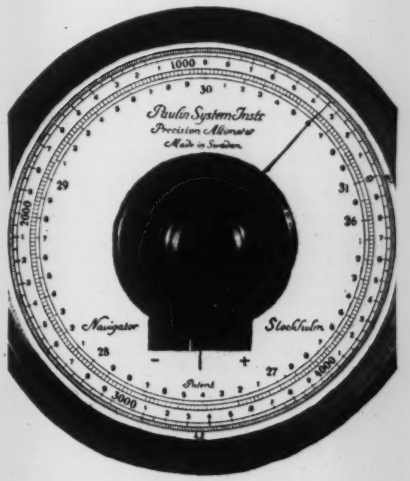
A new type of frost casing for Horton elliptical- and conical-bottom elevated steel tanks, particularly for railway service, has been developed at the Bridgeburg plant of the Chicago Bridge & Iron Works. It consists of hollow tile tied in to form a permanent insulation, as shown in the accompanying drawing.


Expanded metal in horizontal joints
2" No.20ga. bands spaced 3' apart
Red clay tile, 4"x5"x12"
2"x1½"x¼" L's
Cylinder wall
1"x1½" Spacing rings placed 3' apart on cylinder
2"x2" Wooden blocks, spaced 3' c. to c.

On railroad tanks for use in Canada and the extremely cold portions of the northern part of the United States, there is a large cylinder centrally situated under the tank proper, the bottom part of which contains a railroad stove which heats the water in the upper part of the cylinder and the tank itself. To conserve the heat the cylinder is surrounded with an insulating material, separated from the cylinder wall by an annular air space. This new type of casing is composed of red building tile, 4 x 5 in. by 12 in. deep, laid in a vertical position in cement mortar. Expanded metal is placed in each horizontal joint. The vertical joints are staggered. The bottom course is laid upon the concrete center pier which supports the large cylinder, and the top course ends at the bottom of the tank proper. The sketch shows the other details of construction. After completion, the frost casing is given two coats of black graphite.

Differences of Elevation Measured by New Sensitive Aneroid

For measuring differences of elevation or determining altitudes an aneroid instrument called the Navigator, claimed to operate on new principles developed by G. Paulin, a Swedish engineer, has been placed on the market by Navigator Instruments, Inc., San Francisco, Calif. The instrument is built in several models with ranges up to 10,000 ft. and is said to be adapted to the needs of civil and consulting engineers on reconnaissance and topographical survey work, road building, railroad location and investigation of power resources.



The feature of the instrument is the zero gaging method employed for weighing a column of air by the tension of a spring. The action depends upon the transmission of external air pressure through a vacuum diaphragm capsule, the results being transferred to a pointer on a dial by the Paulin system which is said to eliminate lag from friction and inertia since the device employs no gears, levers or chains. The instrument is compensated for changes in temperature

For reconnaissance work there are two types of machine, the first with a range from 1,000 ft. below to 4,000 ft. above sea level, and the second from 1,000 ft. below to 10,000 ft. above sea level. The manufacturer states that differences of elevation of 1 ft. can be read on these instruments.

A third type is the so-called leveling instrument claimed to show differences in elevation as small as 6 in.; its range is from 500 ft. below to 3,000 ft. above

sea level, and it is recommended for preliminary railroad location, highway location, irrigation and power development investigations and general topographical use. For aerial mapping the company manufactures an airplane altimeter.

Publications from the Construction Industry

Porous Plates—NORTON CO., Worcester, Mass., has issued a 27-p. illustrated pamphlet describing its porous acid-proof diffusing plates adapted particularly to the diffusion of air for sewage treatment by the activated-sludge process. The plates are composed of electrically fused alumina grains bonded with an aluminous glass. The standard size for these plates is 12x12x1 in. and there are three grades of material, coarse, medium and fine. The net weight of a standard plate is about 11 lb.

Insulation for Industrial Motors—WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., is distributing "Insulation Guides for Industrial Motors." These guides are designed to be hung on the walls of repair shops where they will be available when motors are being repaired. The different grades and forms of materials used for insulating the various parts of the motors are tabulated in convenient form, making a handy reference card. The insulation methods and materials given on the charts are those used by the Westinghouse company in its machines, and are the result of years of research and experience in developing a line of insulation materials.

Electric Elevator Controllers—CUTLER-HAMMER MANUFACTURING CO., Milwaukee, illustrates and describes a number of types of elevator control apparatus for both passenger and freight elevators in a new 48-p. booklet. The salient features of the equipment are renewable carbon-to-copper power contacts, simple constant-time-limit type of acceleration, and quiet, sure operating, magnetic contactors. A section of the publication is devoted to auxiliary apparatus for use with elevator controllers including reversing switches, floor selectors, limit switches, car switches and door switches.

Steel Sash—BOGERT & CARLOUGH CO., Paterson, N. J., has just issued a 36-p. illustrated catalog on its Boca solid steel sash, the members of which are connected by a patented lock joint made by machine process without welding. The products described and illustrated include side-wall sash, basement windows, casement windows, continuous sash for roof, mechanical operators, steel doors, and steel partitions. Of the company's products one of the new features is a bronze guide for sliding ventilators, inside of which slide steel friction shoes and springs. This catalog contains a great many line drawings showing details of typical sash installations for buildings of different types.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Increase in Steel Output—Cement and Lumber Slower

Steel and Lumber Demand Gaining—Seasonal Drop In Cement Stocks And Shipments

Latest reports on production of basic materials, such as steel, lumber and cement, reveal conflicting trends in volume of output.

Steel is gaining in output and demand, while production of lumber and cement moves more slowly as the season advances.

Production of steel ingots for the nation, according to the American Iron and Steel Institute, has been gaining steadily since July, although the present rate of output is below that of the corresponding period last year, as shown by the following:

	1924 Tons	1923 Tons
July	1,869,416	3,531,458
August	2,541,501	3,695,788
September	2,814,996	3,356,776
Total nine months	26,874,941	33,910,987

The unfilled orders on books of the U. S. Steel Corporation on the last day of each month are shown as follows:

	1924 Tons	1923 Tons
July	3,187,072	5,910,763
August	3,289,577	5,414,663
September	3,473,780	5,035,750

The present trend is upward in steel demand, which is directly opposed to the condition existing one year ago.

Cement mill stocks and shipments are following the regular seasonal trend downward according to the Geological Survey. Production, however, is slower as compared with a gain during the corresponding period in 1923.

The production situation follows:

	1924 Barrels	1923 Barrels
July	14,029,000	12,620,000
August	15,128,000	12,967,000
September	14,519,000	13,109,000
Total nine months	110,463,000	101,427,000

The lumber situation is one of decreased production and shipments, according to reports to the National Lumber Manufacturers' Association as of Oct. 11. During the week of Oct. 11, however, there was a gain in new orders of nearly 4,000,000 ft. over the week preceding.

The following table compares the national lumber movements for the three weeks indicated:

	Week of Oct. 11 Ft.b.m.	Corresponding week in 1923 Ft.b.m.	Preceding week in 1924 Ft.b.m.
Mills	356	391	357
Production	226,414,746	256,097,457	231,670,433
Shipments	217,633,937	229,122,452	232,125,867
New business	207,674,250	225,147,179	203,856,057

The following figures compare the lumber movements for the first forty-one weeks of 1924 with the same period last year:

	Production Ft.b.m.	Shipments Ft.b.m.	Orders Ft.b.m.
1924	9,599,703,522	9,503,926,487	9,193,594,109
1923	10,060,984,375	10,028,698,361	9,545,610,952
1924 Decrease	461,280,853	524,771,874	352,016,843

Industrial Building Contracts Gain in Average Value

Industrial building contracts awarded throughout the United States during the first nine months of this year, at a minimum value of $40,000 and not including commercial construction, numbered 973, as compared with 1,273 for the corresponding period of 1923. The average value per contract was $161,000 for the nine month period of this year against $147,000 for the 1923 period. The total awards for the two compared periods are $156,549,000 and $187,648,000 respectively.

This class of construction so far is below the 1923 record in both number and total value but has surpassed it in average contract value. The accompanying tables show the 1924 monthly awards, number, value of average contract and per cent of total of each class.

CLASSIFICATION OF 1924 INDUSTRIAL BUILDING CONTRACTS ACCORDING TO USE NUMBER AND VALUE (000 OMITTED)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total	Per Cent of Total
Factories	$17,925	$7,398	$9,762	$9,859	$9,396	$5,294	$10,180	$7,787	$8,154	$85,755	54.1
Power plants	6,603	10,784	2,480	1,077	888	1,574	13,505	1,272	5,444	43,627	28.2
Foundries	198	290	125	240	190	90	135	185	40	1,493	.6
Warehouses	3,641	2,734	445	672	5,434	1,050	985	778	2,771	18,510	12.1
Garages	4,149	2,560	40	190	0	0	0	40	185	7,164	5.0
Total	$32,516	$23,766	$12,852	$12,038	$15,908	$8,008	$24,805	$10,062	$16,594	$156,549	100
Number	198	123	97	99	111	77	95	71	102	973	
Ave. contract	$164	$153	$133	$122	$144	$104	$261	$142	$162	$161	

NUMBER OF BUILDING CONTRACTS LET FOR VARIOUS TYPES OF INDUSTRIAL BUILDINGS DURING FIRST 9 MONTHS OF 1924

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total	Average Value of Contract
Factories	97	56	84	70	86	54	62	50	74	633	$136,000
Power plants	12	7	4	14	7	8	20	9	15	96	455,000
Foundries	4	5	1	5	2	1	2	3	1	24	62,000
Warehouses	34	22	7	8	16	14	11	8	9	129	143,000
Garages	51	33	1	2	0	0	0	1	3	91	79,000
Total	198	123	97	99	111	77	95	71	102	973	$161,000

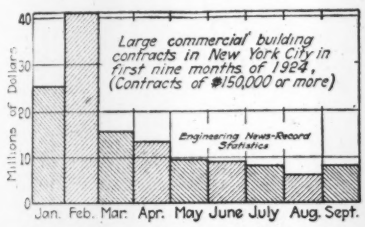
Construction Slower In New York City

Commercial Buildings 18 Per Cent of Country's Total—Decline in Lettings Since February, 1924

Commercial building construction in New York City alone amounts to 18 per cent of the country's total. This class comprises office buildings, hotels and apartment houses, schools, warehouses, theatres and churches. Total building contracts awarded throughout the country in the first nine months of 1924 exceeds $3,500,000,000, and half of this is residential.

The present analysis is concerned with commercial building contracts of $150,000 or more, as reported at first-hand by *Engineering News-Record* this year. The total for the country has exceeded $753,000,000, of which New York City's share is $136,000,000 or 18 per cent.

It is accurately reported that construction is slowing down in New York. Of the large contracts mentioned above, 44 per cent in number and 45 per cent in value were let in January and February. Comparable figures for the rest of the country are 20 per cent in number of contracts and 20 per cent in value for these two months.


Large commercial building contracts in New York City in first nine months of 1924, (Contracts of $150,000 or more)
Engineering News-Record Statistics
Millions Dollars
40
30
20
10
0
Jan. Feb. Mar. Apr. May June July Aug. Sept.

New York's average monthly lettings in the period under consideration is $15,100,000; but the average of the last five months is only $8,000,000.

Figure I shows a consistent decline from February to August, inclusive. The lowest point, August, was $6,278,000. The February peak, $41,000,000, includes one $18,000,000 apartment contract. September would have gone still lower than August except for the courthouse contracts aggregating $4,829,000.

An important reason advanced for this considerable decline is the strike of the structural iron-workers on May 1. An agreement with the employees has not been reached. This has held up erection of steel-frame buildings and has slowed up further lettings in this type of structure.

The downward trend in construction has not gained sufficient momentum to shake the stability of building materials prices that has prevailed in this market for at least a month. There has, however, been a consistent downward movement in construction cost throughout the entire country since May of this year.

Of thirty-five basic construction materials listed regularly in *Engineering New-Record*, twenty-five have shown no price fluctuations since the first week in October. Of the ten remaining, five have advanced and five declined. The increases occurred in iron, reinforcing materials, wood paving blocks, common brick and linseed oil.

Great Britain Regains Italian Steel Market

Great Britain is regaining the Italian steel market, according to reports on the state of trade in a number of European countries as reported in the Bulletin of the Federation of British Industries, a copy of which has been forwarded to the Department of Commerce by Alfred Nutting, Clerk in the American Consular office, London.

According to the Milan correspondent of the Bulletin, a considerable quantity of British steel has been sold there and firms which did business with England in this particular line previous to eight years ago are now renewing relations. It is stated that in some lines of steel, England is able to undersell Germany.

Large Contracts Let During Week

Among the week's announcements of contracts awarded in Construction News, pp. 223 to 236, are the following:

Dredging, Tampa, Fla.; to Northern Dredge & Dock Co., Minneapolis, Minn., $2,000,000.

Club, Los Angeles, Calif., to Scofield Constr. Co., $1,500,000.

Office and Bank, Los Angeles, Calif., to Scofield Engr. Co., $1,500,000.

Street work and storm sewers, Raleigh, N. C., to R. G. Lassiter & Co., $1,000,000.

Dormitories, Raleigh, N. C., to J. E. Beaman, $1,000,000.

High Cost of Materials Reduces British Building

The continued high cost of construction materials in the United Kingdom since the war has reduced building activities to the point where the lack of housing for the working class has become conspicuous, and Parliamentary and other public action has seemed necessary to give requisite home accommodations, advices to the U. S. Dept. of Commerce, from London, state. The first of August, Parliament passed a bill providing for the building of 2,500,000 houses for workingmen during the next 15 years, and also setting aside funds for the granting of subsidies to constructors of houses which comply with the specifications laid down by the Ministry of Health. In Scotland, ever since the war the scarcity of dwelling houses has been acute, and at Dunfermline, according to a report from Howard D. Van Sant, consul at that station, it was proposed to build 1,000 houses to meet the demand, but owing to the high cost of materials and labor the number was reduced, this being partly the result of the discovery that builders could not be found to

(*Continued on p. 692*)

Business Briefs

Call money remained at 2 per cent, Oct. 20.

Time loans; short terms, 2½@3 per cent; longer periods, 3¼@3½ per cent.

Commercial paper; best names, 3@3¼ per cent; other names, 3½ per cent.

Foreign Exchange (Demand):

	Normal	This Week	Last Week	Year Ago
Sterling	$4.8665	$4.48⅞	$4.48⅛	$4.49¼
Franc	0.193	0.0522	0.0522	0.0528
Lira	0.193	0.0435½	0.0436¼	0.0443½

Bids Wanted on Big Jobs

Among the projects in Construction News, pp. 223 to 236, on which bids are either asked or will soon be called are the following:

Office and Theater, Los Angeles, Calif., for C. E. Taberman, $1,200,000.

Steel Bridges, Merced, Calif., Merced Irrigation Dist., $1,000,000.

Labor Two-Thirds of Industrial Painting Cost

Industrial construction for the entire country, during the first nine months of the current year, amounted to $156,549,000 in contracts awarded, according to *Engineering News-Record*. This is compared with $201,393,000 for the record year 1923. No contracts under $40,000, however, were included in these totals.

It developes that plumbing, heating, lighting and painting costs in these projects, amounted to $15,745,000, of which heating was the principal factor, with a total value of $5,640,000, during the period, Jan. 1 to Oct. 1, 1924.

CONTRACTS AWARDED ON LARGE BUILDINGS JAN. 1 to OCT. 1, 1923-4

	Industrial $40,000 and up	Commercial $150,000 and up
1924	$156,549,000	$753,453,000
1923	201,393,000	667,136,000

In the painting operations, labor accounted for two-thirds of the total cost, as shown by the table below.

Commercial building awards of $150,000 and over, amounted to $753,453,000 for the first nine months of this year, against $667,136,000 during the corresponding period in 1923.

Plumbing, heating, lighting and painting costs in these buildings, amounted to $93,940,000, against $83,375,000 for the same months last year.

As in industrial buildings, heating constituted the principal expense in the four items under consideration.

Painting costs for both classes of buildings during the nine-month periods, this year and last, as divided into separate costs of labor and materials, are shown in the accompanying tabulation.

PLUMBING, HEATING, LIGHTING AND PAINTING COSTS OF BUILDINGS

	Industrial Buildings		Commercial Buildings	
	1924	1923	1924	1923
Plumbing	$815,000	$1,040,000	$15,020,000	$13,340,000
Heating	5,640,000	7,200,000	37,600,000	33,350,000
Lighting	4,340,000	5,540,000	26,300,000	23,345,000
Painting:	4,950,000	6,320,000	15,020,000	13,340,000
(a) materials	1,980,000	2,528,000	6,008,000	5,336,000
(b) labor	2,970,000	3,792,000	9,012,000	8,004,000
Totals	$15,745,000	$20,100,000	$93,940,000	$83,375,000
Per cent change	minus 22		plus 11	

High Cost of Materials Reduces British Building

(*Continued from p.* 691)

However, during the past two years between 350 and 400 reinforced concrete houses, mostly of the middle class or workingman's model, containing from 4 to 6 rooms and bath, have been erected in Dunfermline proper, while at Garden City, the residential part of the Rosyth naval base, some 500 small houses, built of brick, stone or concrete, have been constructed. These houses at Rosyth, to a considerable extent, have been built to take the place of the corrugated iron houses erected to accommodate workingmen at the naval base in the early days of its construction and during the first years of the war period.

In some sections more pretentious dwellings have been built and a number of large and modern school buildings have been erected. Nearly all of this construction has been made through the guarantee of costs by municipal or other public associations. But for such financial backing the work could not ordinarily be undertaken at this time, owing to the disinclination of leading builders and contractors to proceed with construction, along with the general tightness of ready money for such investments.

Aside from this pressingly required construction—and it would appear that the need for more house-building continues to be pressing in spite of the work already done—proposals for similar operations are being postponed until such time as financial conditions improve or the supply of lumber, hardware and building materials is increased and their cost has been reduced to something like pre-war prices, when construction work and labor might be obtained at about half the present cost. Heavily increased taxes and rates have also caused hesitation in building operations since the war. Several large and important construction proposals formulated since the war have been abandoned or held in abeyance.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of October 2, the next, on November 6.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$4.00	$3.00	$3.35	$3.50
Structural rivets, 100 lb.	3.75	4.35	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.30	3.38	3.00	3.25	3.87½	3.35	3.25	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	44%	54.2%	43%	53%	55.05%	36%	—43.1@54.4%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	56.60@57.60	54.00	+59.00	56.20@57.20	55.50	68.00	56.00	65.00	65.00
Concreting Material:									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.20	2.42	2.84	2.61	2.90	1.80
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	2.75	—1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.40	2.00	2.75	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	2.75	1.75	3.50	2.15	3.00	2.25
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	55.00	35.00	57.20	55.00	37.75	34.75	29.00	26.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	—23.00	24.00	22.60	24.00	21.00
Lime common, lump, per bbl.	2.50@3.00	1.45	1.85	1.50	1.40	2.70	2.15	2.80	10.50
Common brick, delivered, 1,000	18@19	11.00	+12.10	12.00	14.00	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.1004	.0941	.089	.07	.085	....	.11	.12
Hollow partition tile 4x12x12, per block	.1162	.1004	.0941	.089	....	.085	.108	.11	.10
Linseed oil, raw, 5 bbl. lots, gal.	+1.08	1.11	1.20	1.05	+1.13	+1.23	—1.12	1.12	1.13
Common Labor:									
Common labor, union, hour	.75	.30	.....	.82½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	....	.25	.40@.75	.75	.50@.55	.35@.50	.50	.62½	—.25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; **45-5%** means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b.

Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 62½c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; lump finishing lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.60 for Kelly Island and Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand stone, gravel and lump lime per ton. Stone, lime and tile are delivered; sand, gravel and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $37.83.

Conditions Affecting the Market

Advances are still in excess of declines in the construction materials market, according to reports received this week by *Engineering News-Record*.

Firmness is especially noticeable in c.-i. pipe, pine and fir lumber, common brick and linseed oil. Wrought-steel pipe is in better demand in all sections of the country except the Far West.

Pine lumber demand has improved considerably in the Mississippi mill area and also in New York and Chicago, during the past week. Weakness in the pine market, however, continues in Cincinnati and St. Louis.

Brick are holding firmly to quotations between $18 and $19 per M., delivered to job in New York. The closing down of all remaining plants in the Hudson River district will tend toward price firmness during the next two months.

Linseed oil rose 3c. in New York and 5c. per gal. in Denver during the week. A drop of 2c., however, is reported in San Francisco. This material is regarded as being a barometer of the paint trade.

Active shipments of pig iron are cutting into reserve stocks, with the result that prices are holding firmly at levels prevailing since Oct. 1.

Railroads continue to take the bulk of the steel tonnage now being sold. Some weakness in steel shapes has developed during the week, with quotations at $1.90@$2 per 100 lb., Pittsburgh. Reinforcing bars are firm, however, at $2 while plates bring $1.60@$1.90 per 100 lb., at mill.

The principal non-ferrous metals are firmer all along the line in the domestic market. Copper advanced ¼c. and lead and zinc, ⅛c. per lb., in New York warehouses since Oct. 10.